

# NASA TECHNICAL MEMORANDUM

NASA TM X-64674

A CATALOGUE OF NORMALIZED INTENSITY FUNCTIONS AND  
POLARIZATION FROM A CLOUD OF PARTICLES WITH A SIZE  
DISTRIBUTION OF  $a^{-4}$

By P. D. Craven and G. A. Gary

Space Sciences Laboratory  
Science and Engineering

August 1972 (Revised edition)

**NASA**

*George C. Marshall Space Flight Center  
Marshall Space Flight Center, Alabama*

N72-28717

(ACCESSION NUMBER)

164

(PAGES)

(NASA CR OR TMX OR AD NUMBER)

(THRU)

1

(CODE)

G3/24

(CATEGORY)

**NASA TM X-64674**

**August 1972 (Revised edition)**

**This TM X replaces an earlier TM X of the same number and dated February 7, 1972. The earlier TM X should be discarded and this revised edition, incorporating corrections to printing errors, substituted.**

|  |  |  |   |   |  |
|--|--|--|---|---|--|
| 1. REPORT NO.<br>TM X 64674  |  | 2. GOVERNMENT ACCESSION NO.                          |   | 3. RECIPIENT'S CATALOG NO.                                  |  |
| 4. TITLE AND SUBTITLE<br>A Catalogue of Normalized Intensity Functions and Polarization<br>From a Cloud of Particles with a Size Distribution of $\alpha^{-4}$   |  |  |   | 5. REPORT DATE<br>August 1972 (Revised edition)             |  |
|  |  |  |   | 6. PERFORMING ORGANIZATION CODE                             |  |
| 7. AUTHOR(S)<br>By P. D. Craven and G. A. Gary   |  |  |   | 8. PERFORMING ORGANIZATION REPORT #                         |  |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>George C. Marshall Space Flight Center<br>Marshall Space Flight Center, Alabama 35812   |  |  |   | 10. WORK UNIT NO.   |  |
|  |  |  |   | 11. CONTRACT OR GRANT NO.                                   |  |
| 12. SPONSORING AGENCY NAME AND ADDRESS<br>National Aeronautics and Space Administration<br>Washington, D. C. 20546   |  |  |   | 13. TYPE OF REPORT & PERIOD COVERED<br>Technical Memorandum |  |
|  |  |  |   | 14. SPONSORING AGENCY CODE                                  |  |
| 15. SUPPLEMENTARY NOTES<br>Prepared by Space Sciences Laboratory, Science and Engineering  |  |  |   |   |  |
| 16. ABSTRACT<br><br>The Mie theory of light scattering by spheres is used to calculate the scattered intensity functions resulting from single scattering in a polydispersed collection of spheres. The distribution used behaves according to the inverse fourth power law; graphs and tables for the angular dependence of the intensity and polarization for this law are given. The effects of the particle size range and the integration increment are investigated. |  |  |   |   |  |
| 17. KEY WORDS  |  |  | 18. DISTRIBUTION STATEMENT<br><br>ANNOUNCE IN STAR<br><br><i>Paul D. Craven</i> |   |  |
| 19. SECURITY CLASSIF. (of this report)<br>Unclassified   |  | 20. SECURITY CLASSIF. (of this page)<br>Unclassified |   | 21. NO. OF PAGES<br>164                                     |  |
|  |  |  |   | 22. PRICE<br>NTIS   |  |

# DISTRIBUTION

## INTERNAL

DIR

Dr. E. Rees

DEP-T

Dr. W. Lucas

AD-S

Dr. E. Stuhlinger

A&TS-PAT

Mr. Wofford

PM-PR-M

A&TS-MS-H

A&TS-MS-IP (2)

A&TS-MS-IL (8)

A&TS-TU (6)

S&E-DIR

Dr. H. Weidner

S&E-SSL-DIR

Mr. G. Heller

S&E-SSL-X

Mr. H. Weathers

S&E-SSL-P

Dr. R. Naumann

S&E-SSL-PO

Mr. J. Williams

Mr. W. Moore

S&E-SSL-PA

Mr. P. Tashbar

S&E-SSL-S

Dr. W. Sieber

S&E-SSL-SE

Mr. L. Yarbrough

S&E-SSL-T

Mr. W. Snoddy

S&E-SSL-TE

Mr. E. Miller

S&E-SSL-TT

Mr. B. Jones

Dr. M. Hagyard

Mr. P. Craven (15)

Dr. A. Gary (15)

S&E-SSL-N

Dr. R. Decher

S&E-SSL-C

Reserve (15)

## EXTERNAL

Scientific and Technical Information  
Facility (25)

P. O. Box 33

College Park, Maryland 20740

Attn: NASA Representative (S-AK/RKT)


## APPROVAL

# A CATALOGUE OF NORMALIZED INTENSITY FUNCTIONS AND POLARIZATION FROM A CLOUD OF PARTICLES WITH A SIZE DISTRIBUTION OF $\alpha^{-4}$

By P. D. Craven and G. A. Gary

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.

  
WILLIAM C. SNODDY  
Chief, Space Thermophysics  
Division

  
GERHARD B. HELLER  
Director, Space Sciences  
Laboratory

## REFERENCES

1. Born, Max; and Wolf, Emil: Principles of Optics. Pergamon Press, 1965, pp. 633-664.
2. Kerker, Milton: The Scattering of Light and other Electromagnetic Radiation. Academic Press, 1969, pp. 39-63.
3. Stratton, J. A.: Electromagnetic Theory. McGraw-Hill Book Company, Inc., 1941, pp. 563-573.
4. Bicket, N. A.; and Gary, G. A.: Mie Scattering: A Computer Program and an Atlas. NASA TMX-53951, September 1969.
5. Penndorf, Rudolf: Angular Mie Scattering. Journal of the Optical Society of America, vol. 52, 1962, pp. 402-408.
6. Abramowitz, Milton; and Stegun, Irene A.: Handbook of Mathematical Functions. National Bureau of Standards, Applied Mathematics Series No. 55, 1964.
7. Dave, J. V.: Effect of Coarseness of the Integration Increment on the Calculation of the Radiation Scattered by Polydispersed Aerosols. Applied Optics, vol. 8, No. 6, June 1969.

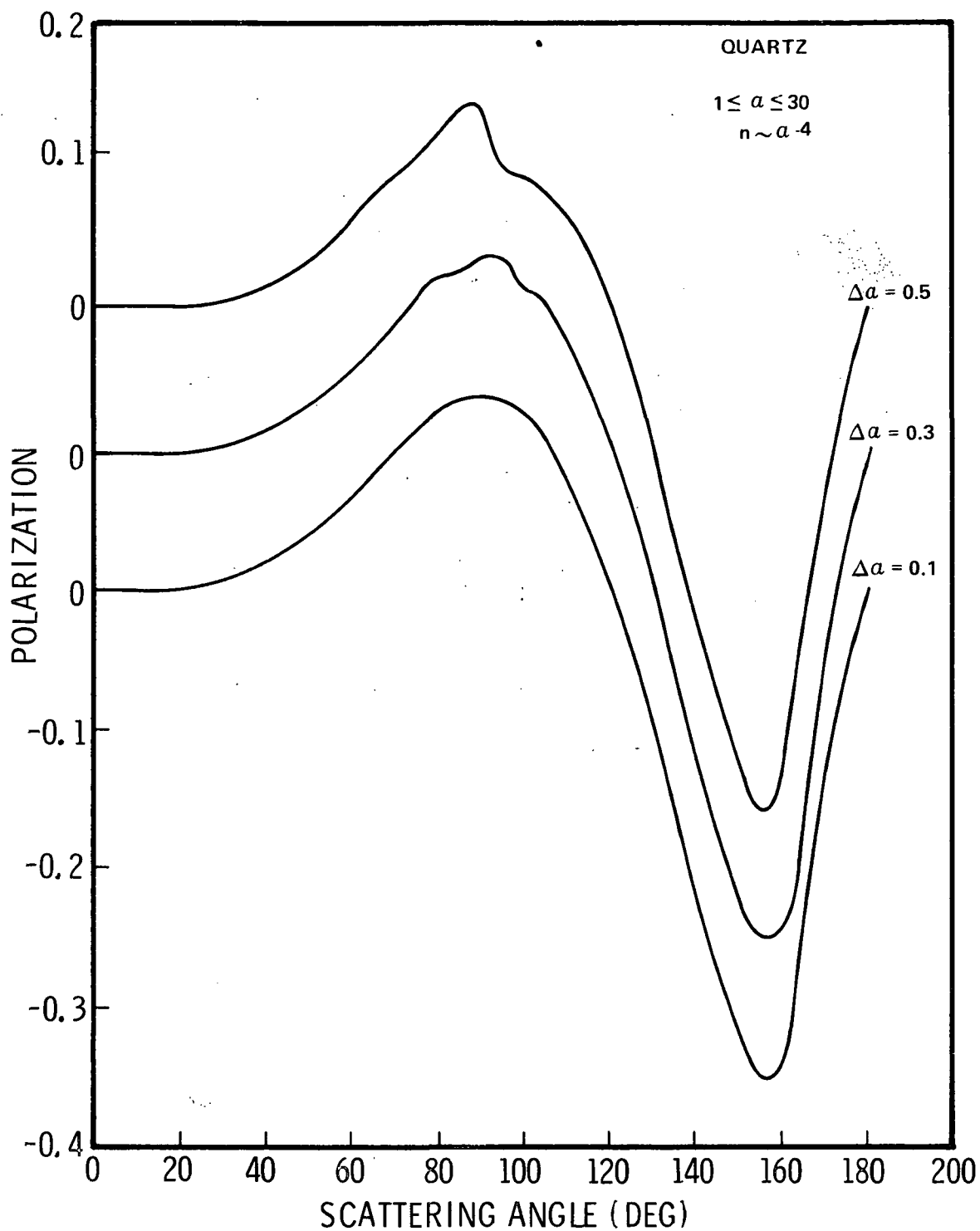


Figure A-15. Comparison of the degree of polarization for quartz obtained from the trapezoidal rule and integration increments of  $\Delta \alpha = 0.1, 0.3$ , and  $0.5$ .

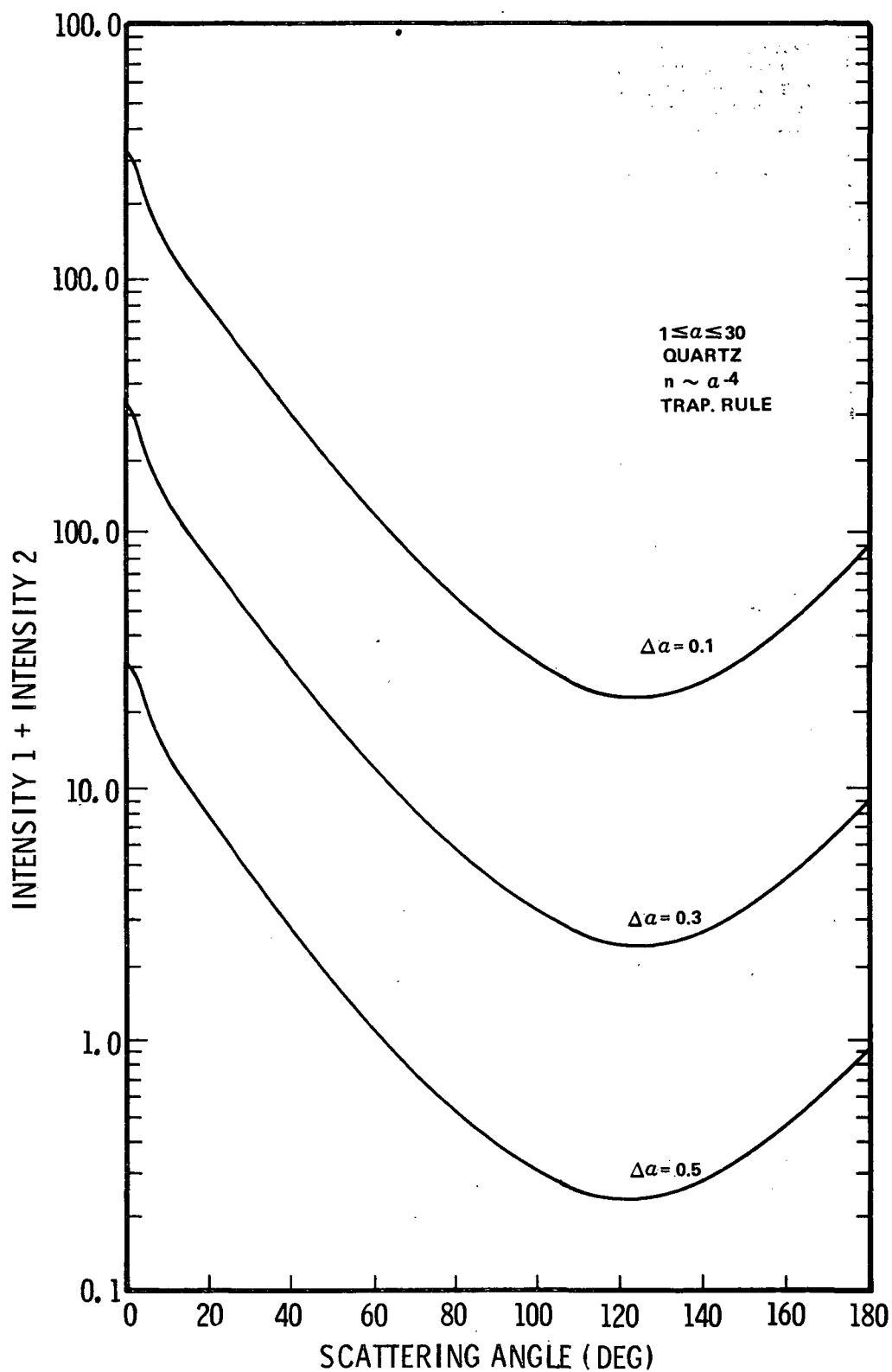


Figure A-14. Total intensity curves for quartz as obtained from the trapezoidal rule and integration increments of  $\Delta \alpha = 0.1, 0.3$ , and  $0.5$ .



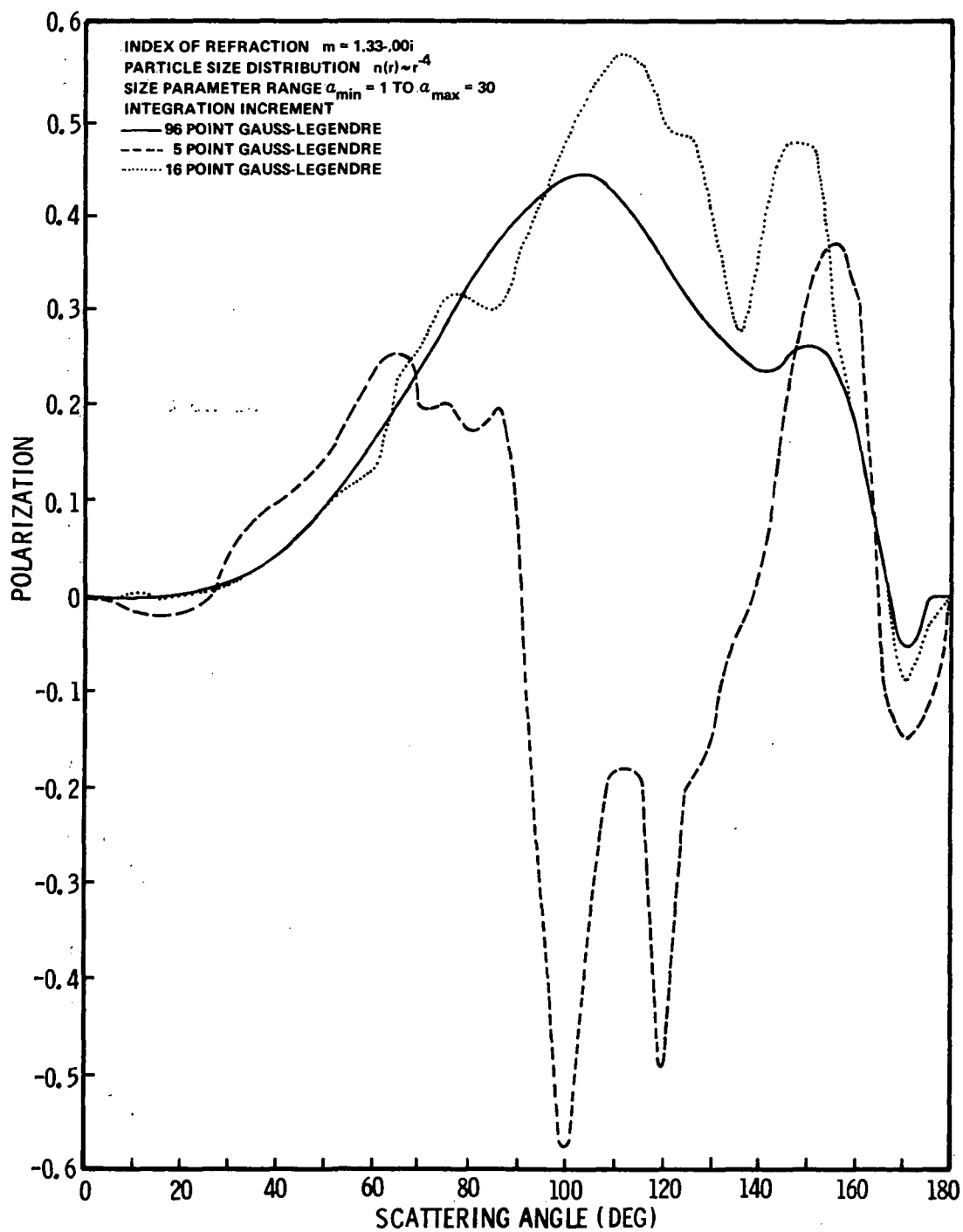


Figure A-13. A comparison of the degree of polarization from three Gauss-Legendre integration schemes .

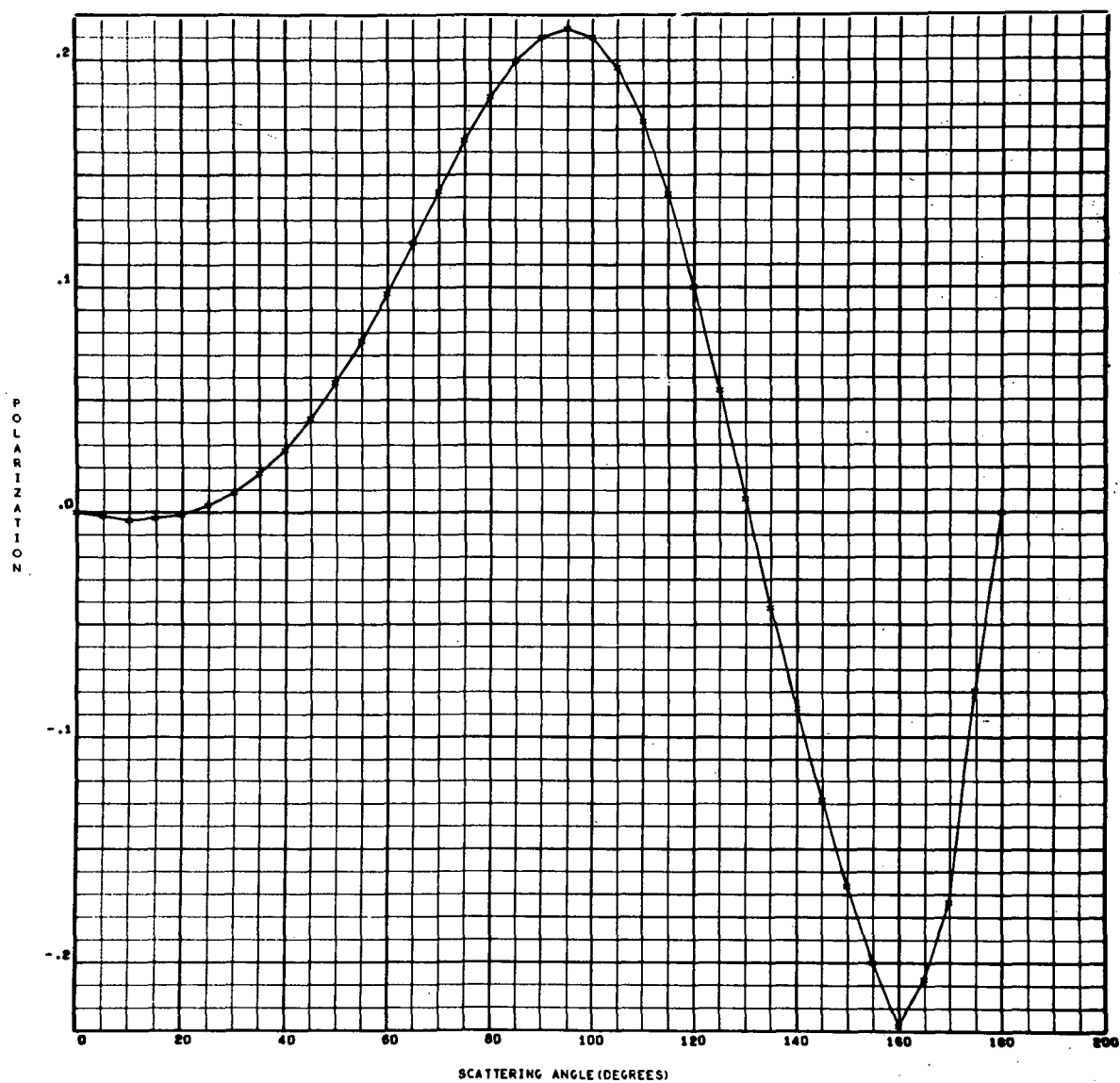


Figure A-12. Degree of polarization from the trapezoidal rule using a mixture of half quartz and half ice ( $\Delta \alpha = 0.1$ ).

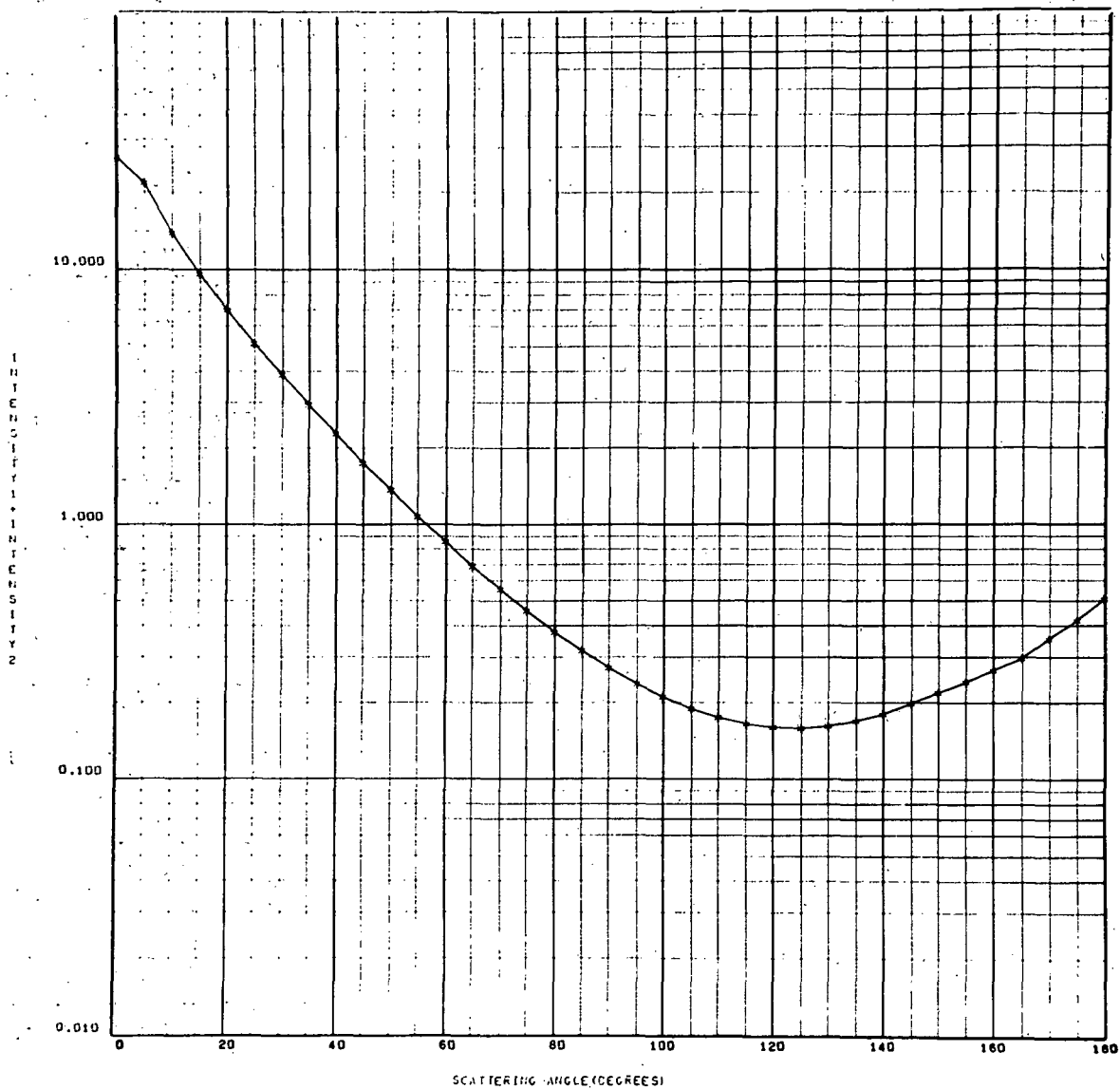


Figure A-11. Total scattering intensity function from the trapezoidal rule for a mixture of half quartz and half ice ( $\Delta \alpha = 0.1$ ).

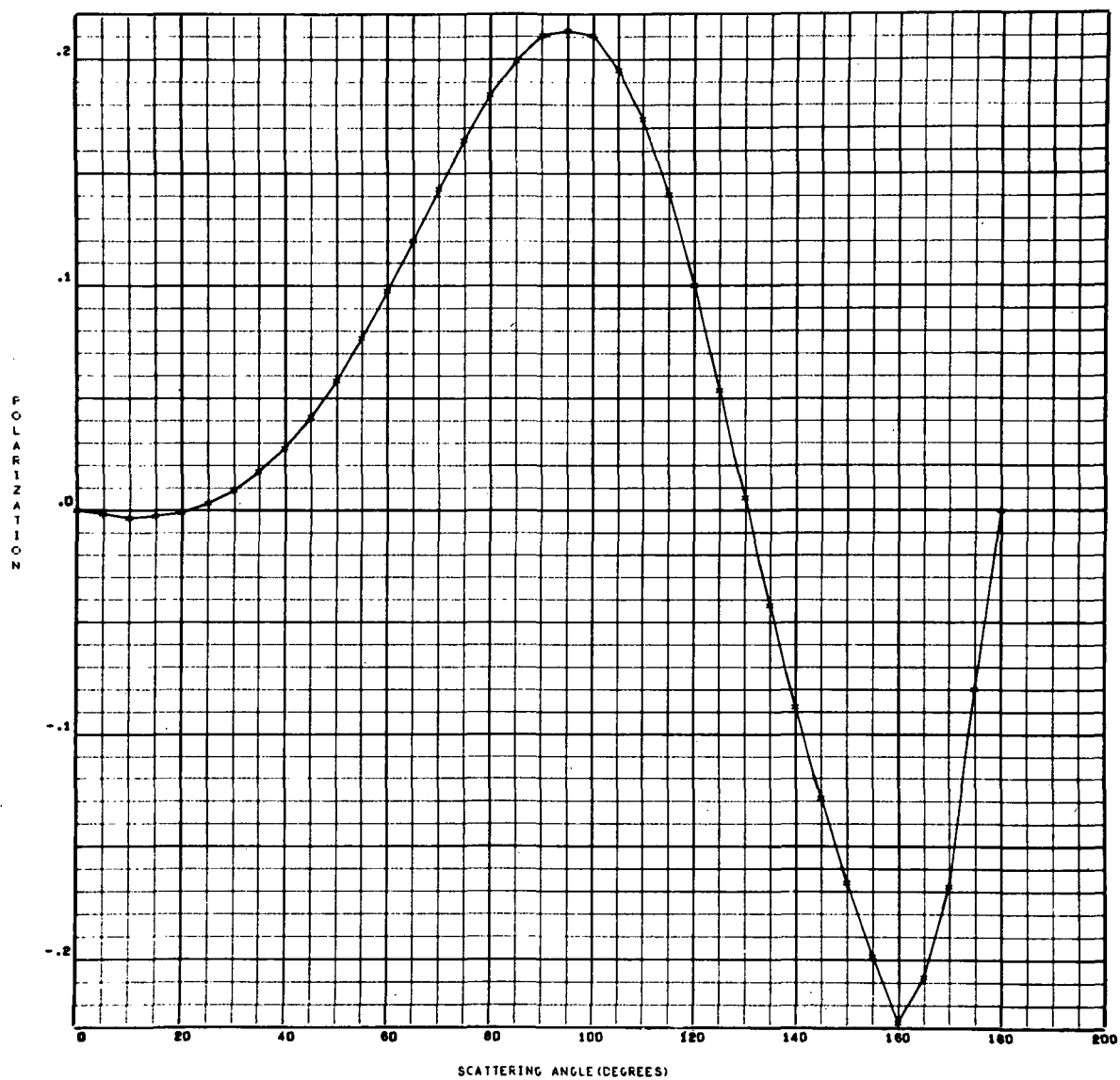


Figure A-10. Degree of polarization for 50 percent quartz, 50 percent ice mixture using the 96-point Gaussian quadrature ( $\alpha$  min = 1.0,  $\alpha$  max = 20.0).

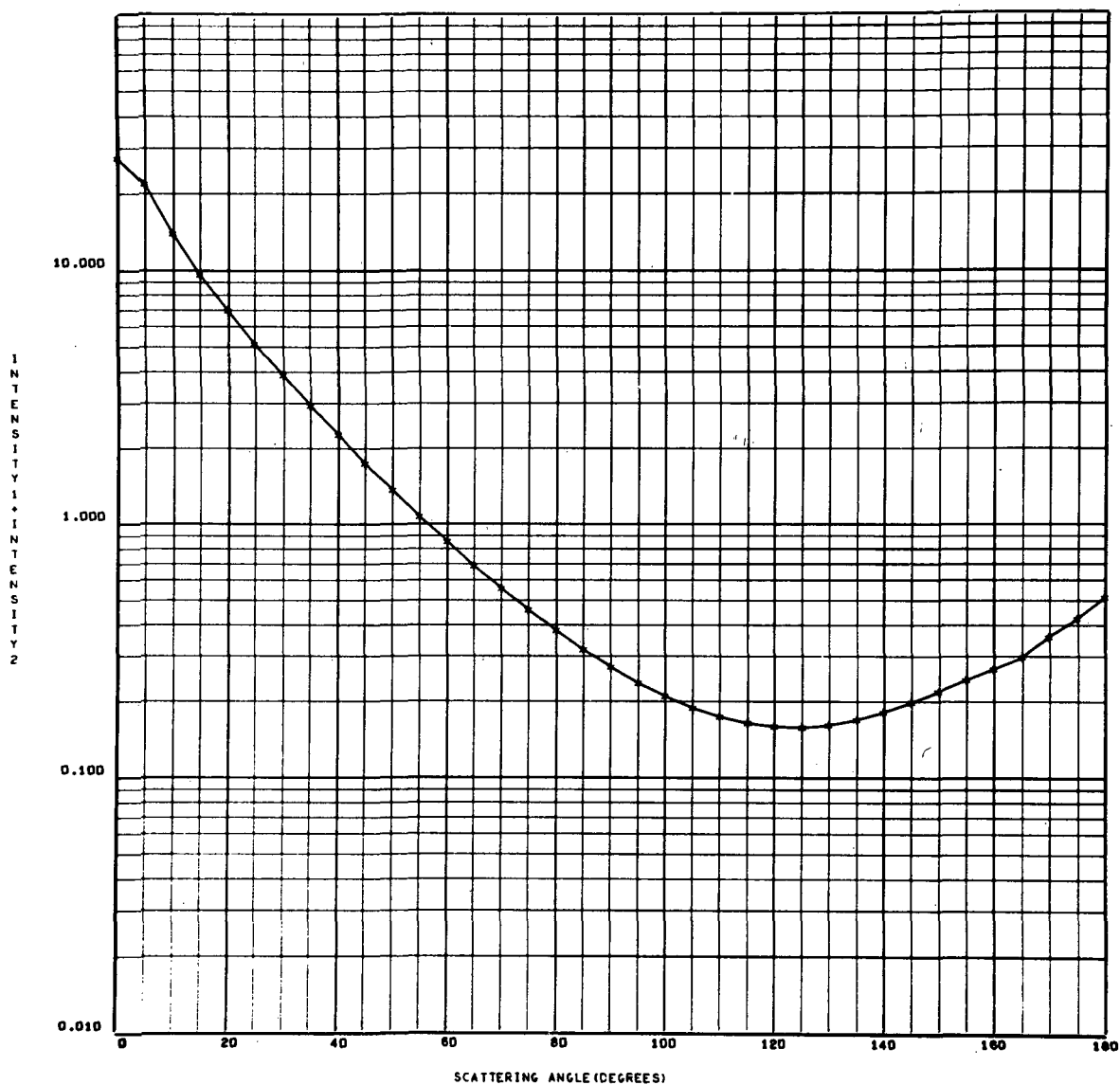


Figure A-9. Total scattering intensity function for 50 percent quartz,  
 50 percent ice using the 96-point Gaussian quadrature  
 ( $\alpha$  min = 1.0,  $\alpha$  max = 20.0).

ZINC  
 $M = 1.41 - 4.10i$   
 $1 \leq \alpha \leq 30$

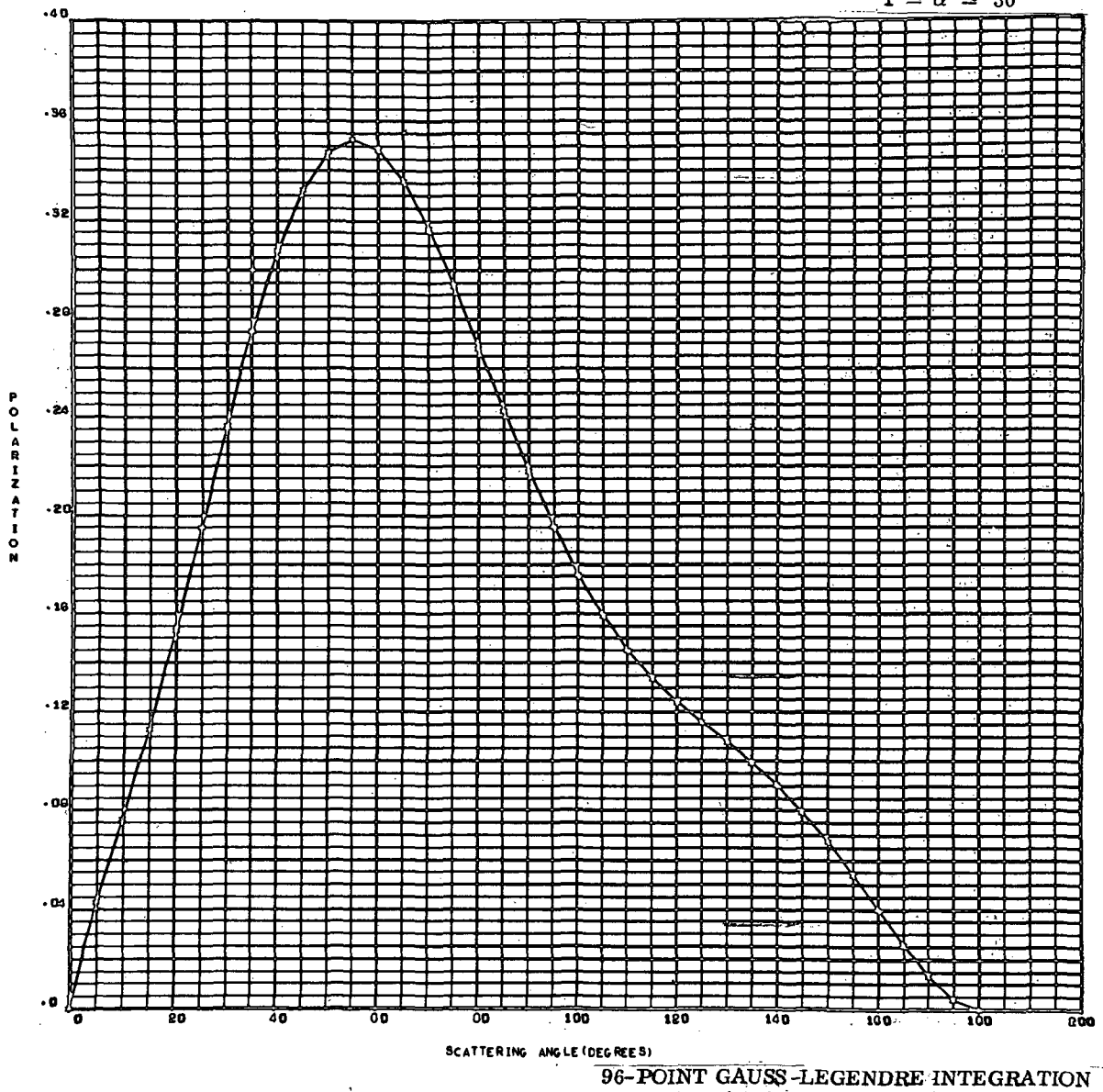
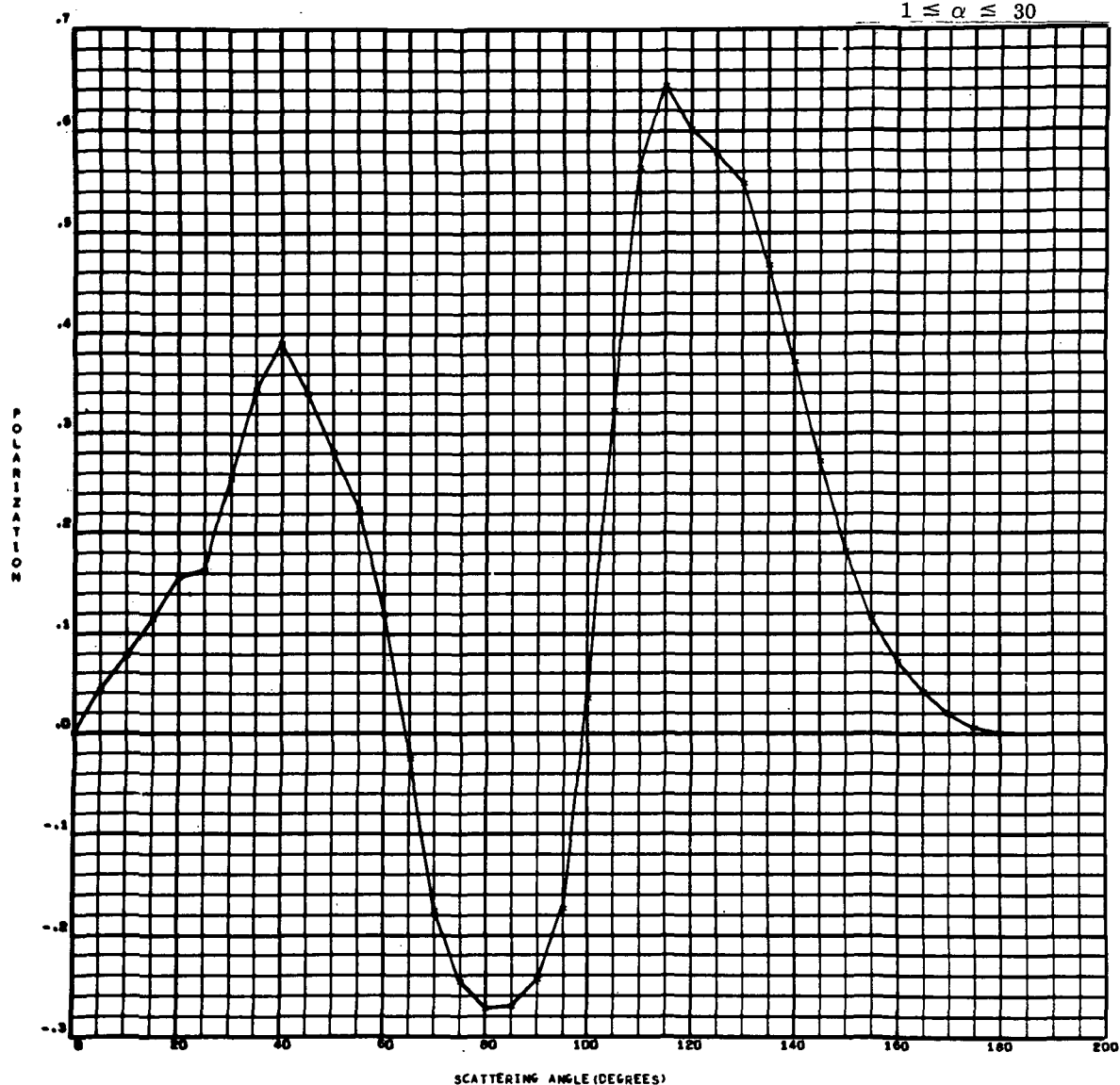


Figure A-8. Degree of polarization for zinc using the 96-point Gauss-Legendre integration.

ZINC  
 $M = 1.41 - 4.10i$   
 $1 \leq \alpha \leq 30$



5-POINT GAUSS-LEGENDRE INTEGRATION

Figure A-7. Degree of polarization for zinc from the 5-point Gauss-Legendre integration .

ZINC

$M = 1.41 - 4.10i$

$1 \leq \alpha \leq 30$

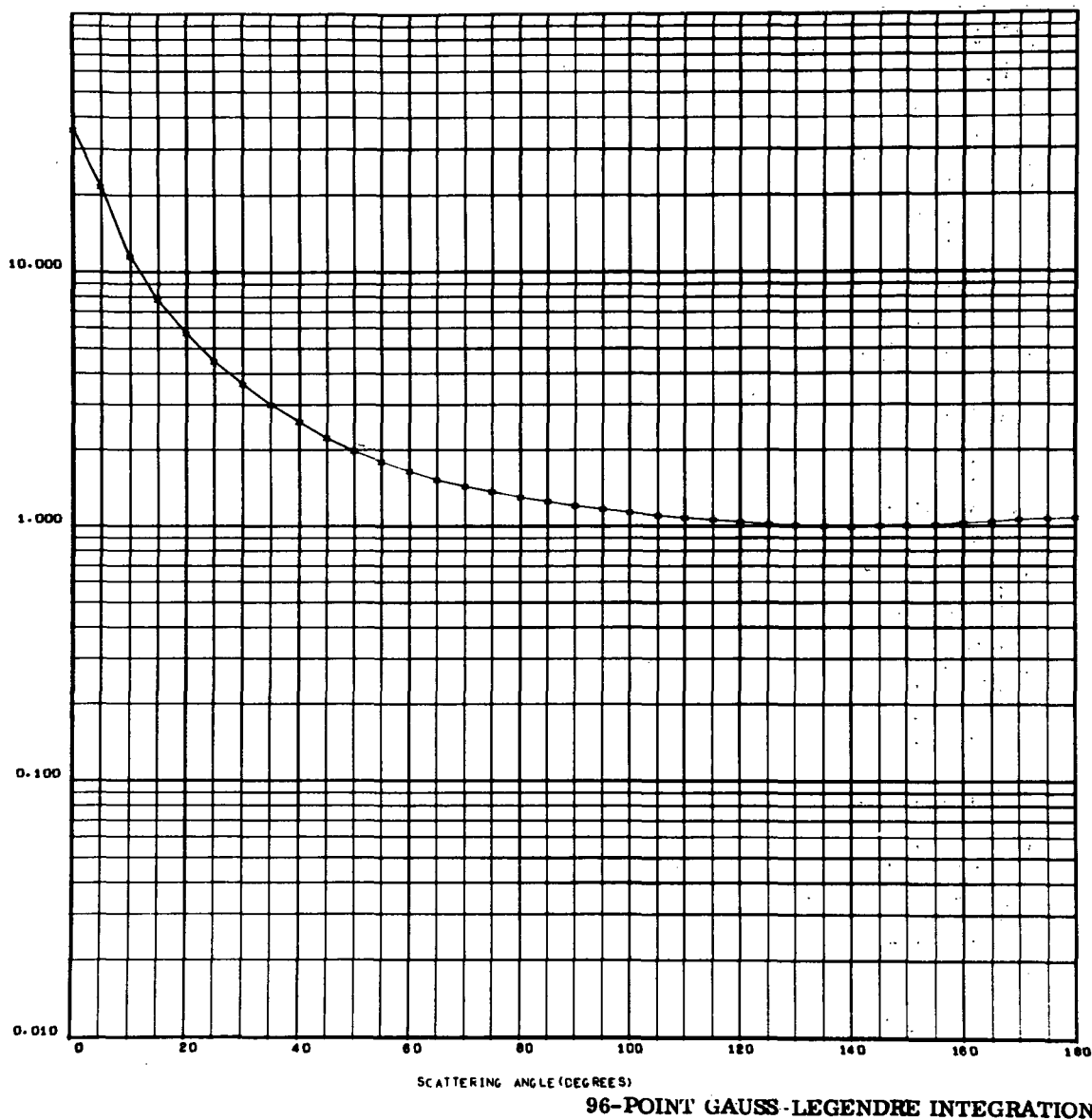


Figure A-6. Total scattering intensity function for zinc using the 96-point Gauss-Legendre integration .



ZINC  
 $M = 1.41 - 4.10i$   
 $1 \leq \alpha \leq 30$

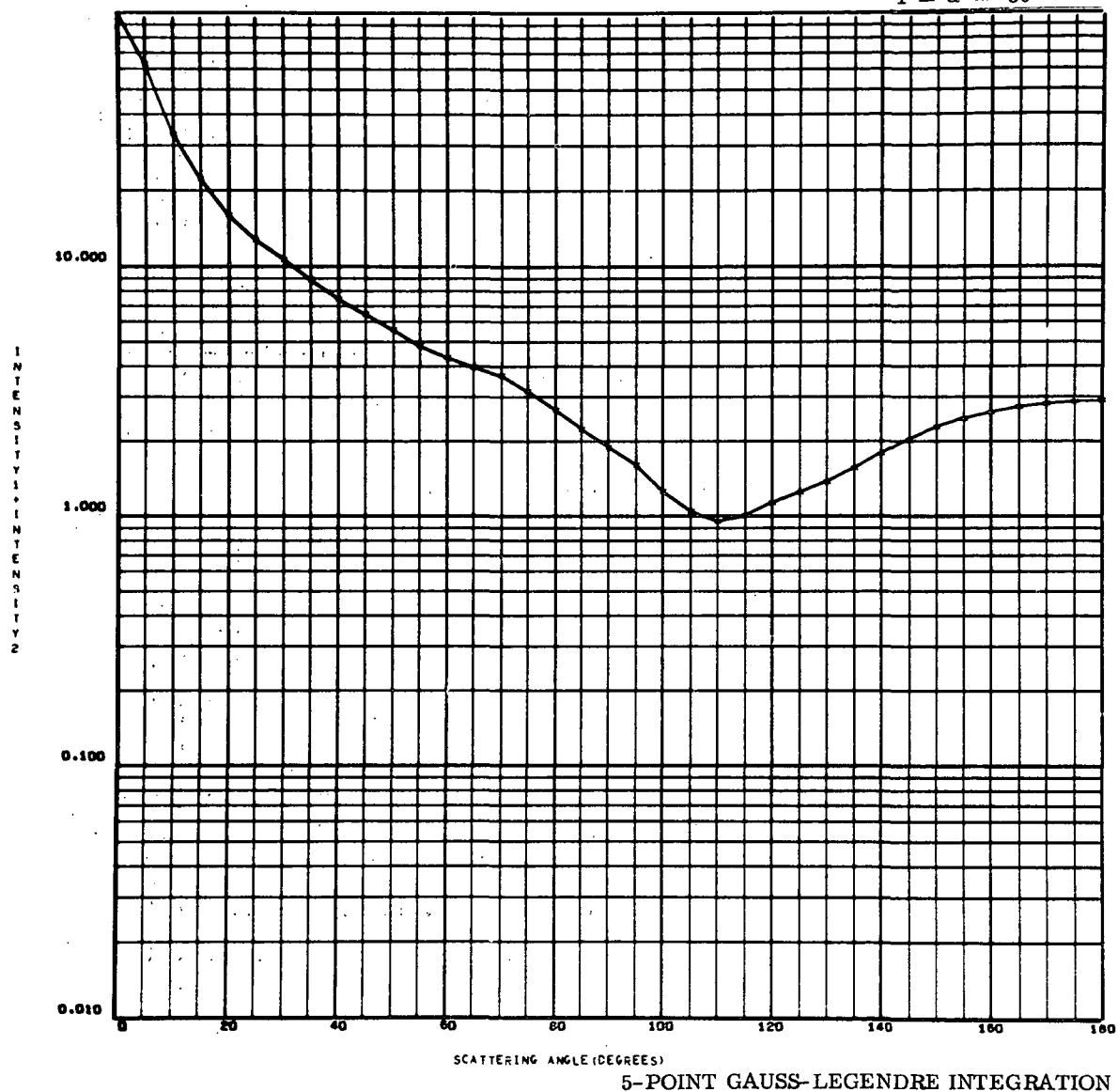
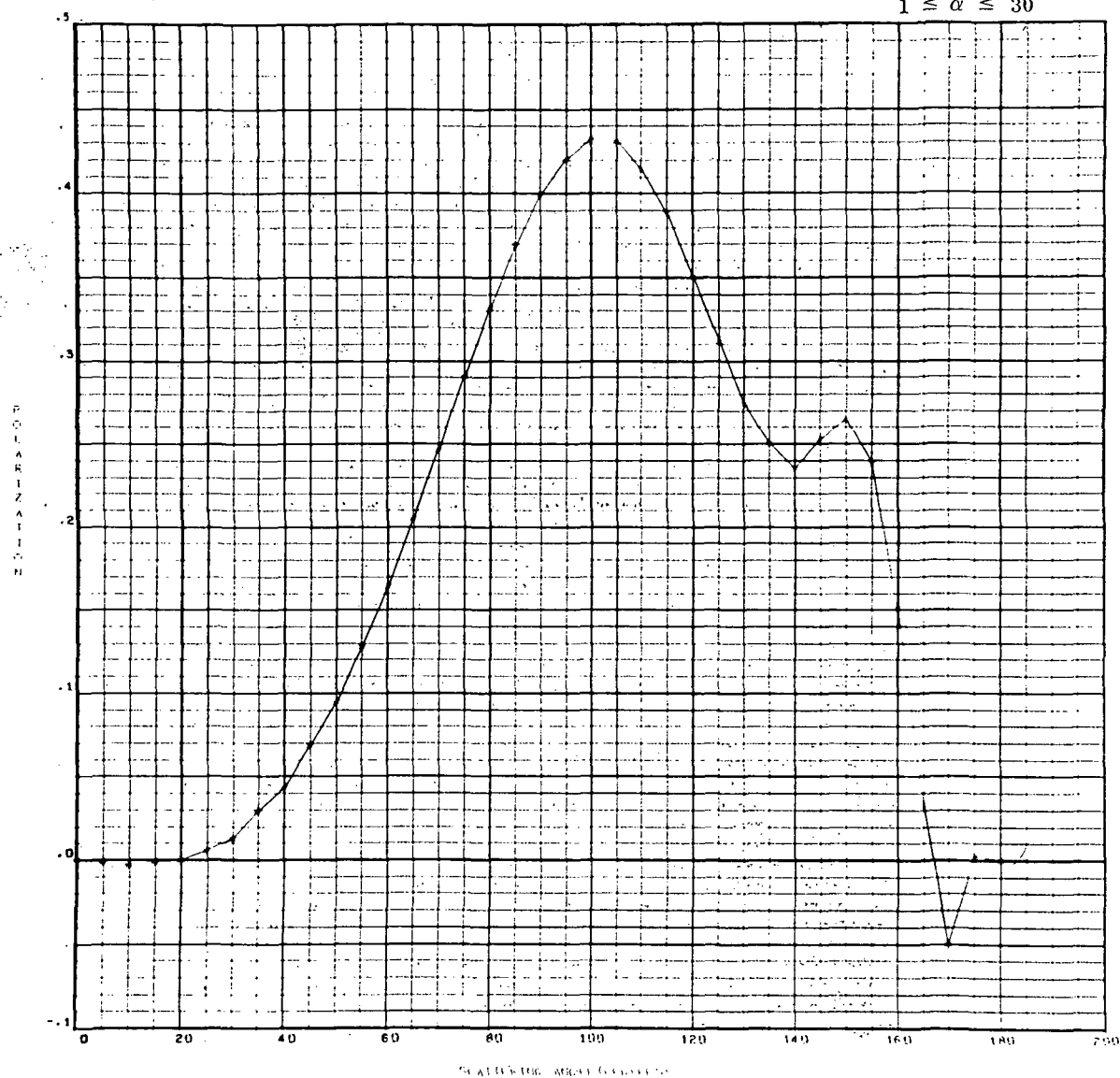


Figure A-5. Total scattering intensity function for zinc using the 5-point Gauss-Legendre integration .

WATER (ICE)  
 $M = 1.33 - 0.00i$   
 $1 \leq \alpha \leq 30$



96-POINT GAUSS-LEGENDRE INTEGRATION

Figure A-4. Degree of polarization for water using the 96-point Gauss-Legendre integration.

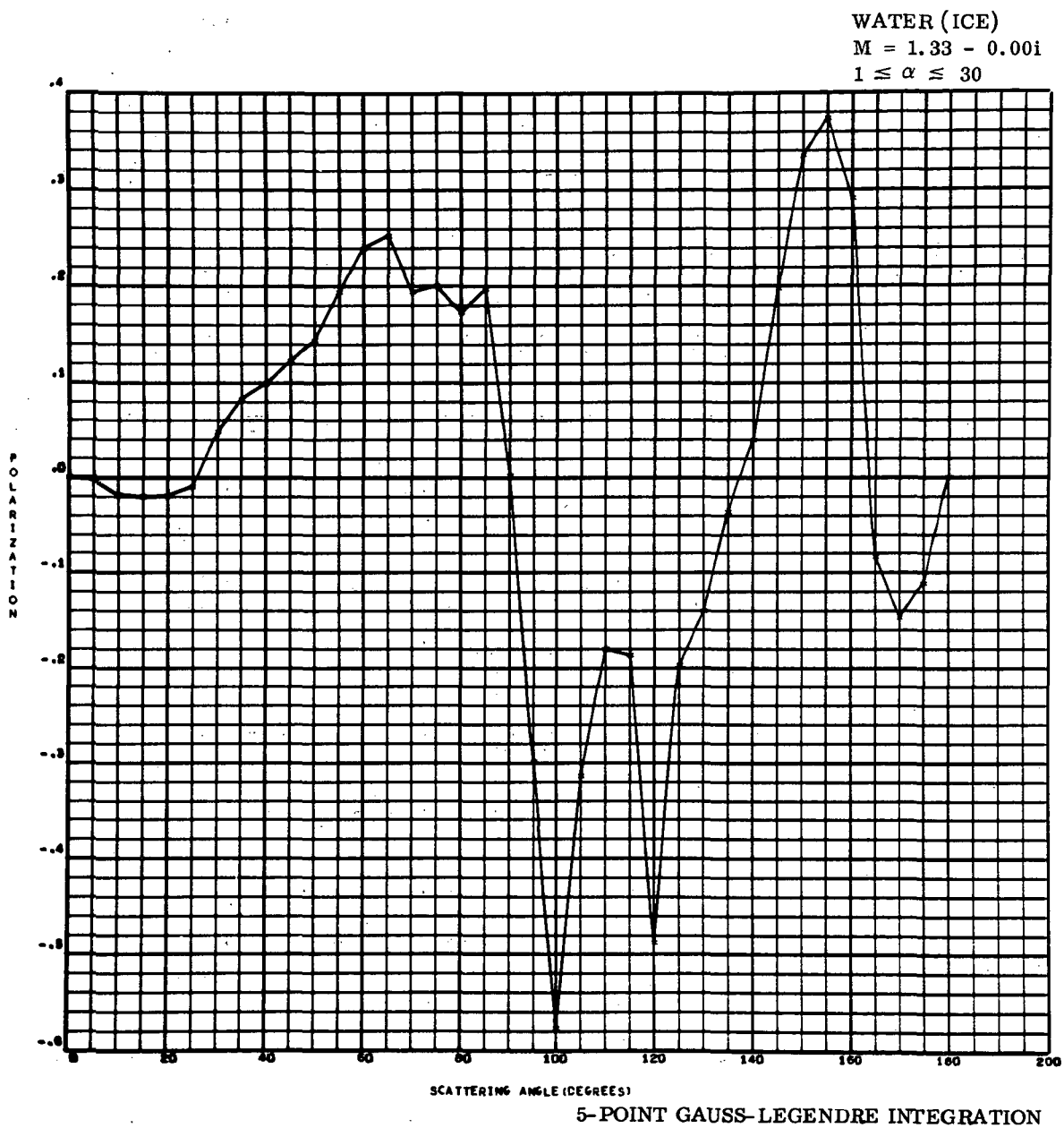
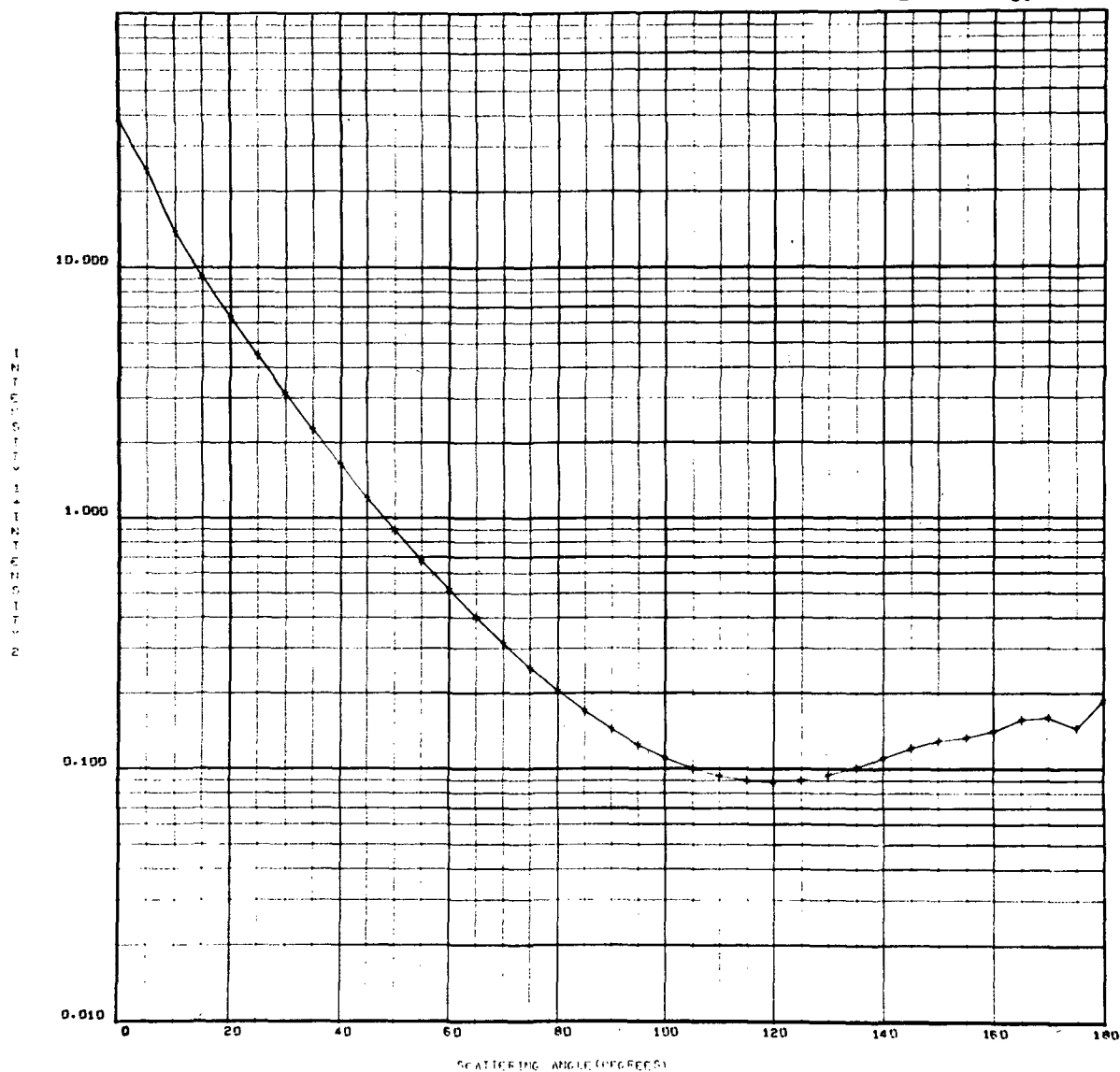


Figure A-3. Degree of polarization for water from the 5-point Gauss-Legendre integration .

WATER (ICE)  
 $M = 1.33 - 0.00i$   
 $1 \leq \alpha \leq 30$



96-POINT GAUSS-LEGENDRE INTEGRATION

Figure A-2. Total scattering intensity function for water using the 96-point Gauss-Legendre integration .

WATER (ICE)  
 $M = 1.33 - 0.001$   
 $1 \leq \alpha \leq 30$

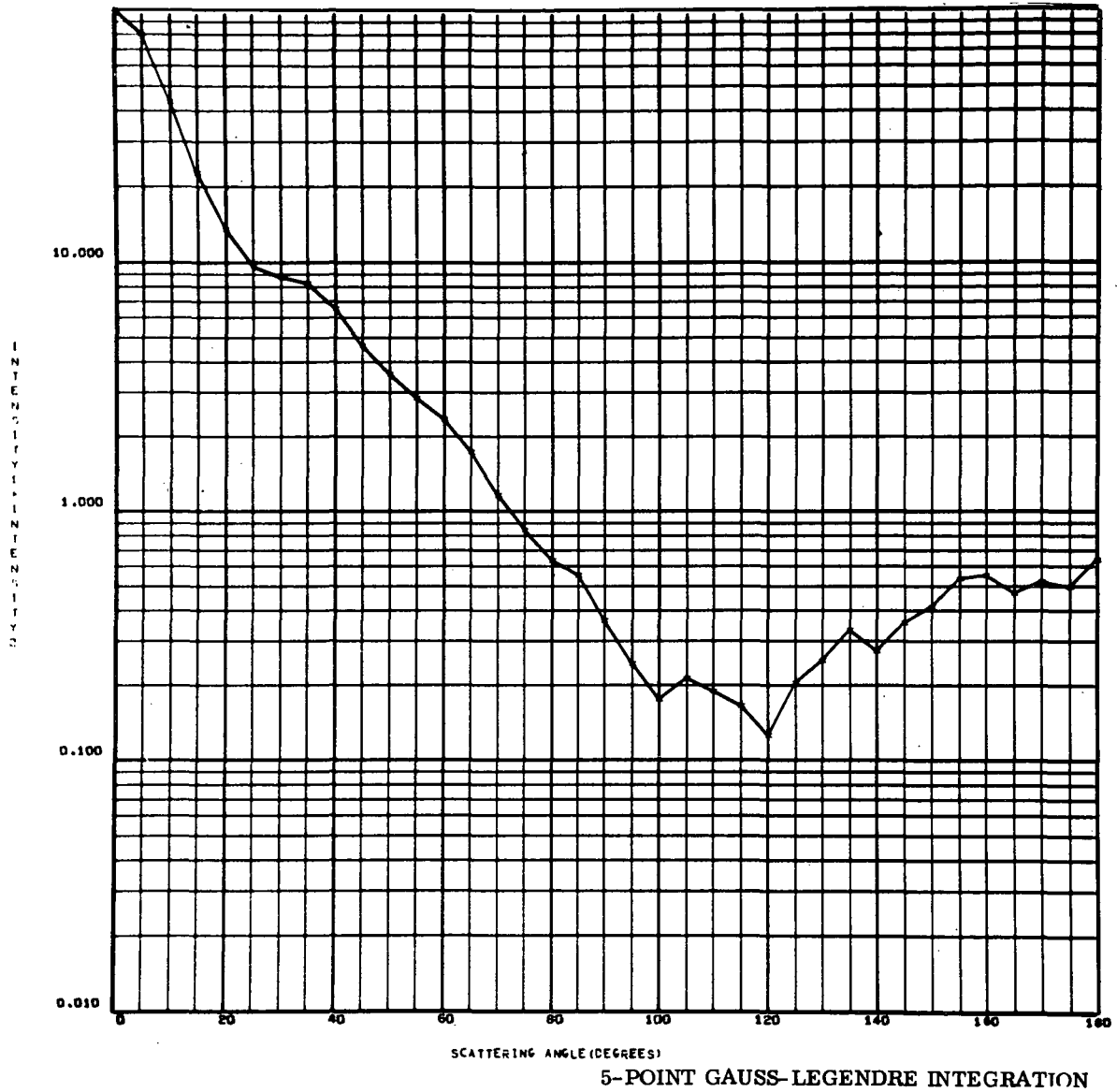


Figure A-1. Total scattering intensity function for water from the 5-point Gauss-Legendre integration.

TABLE A-1. COMPARISON OF 96-POINT GAUSS-LEGENDRE  
AND TRAPEZOIDAL QUADRATURE FOR MIXTURE  
OF QUARTZ AND ICE ( $1 \leq \alpha \leq 20$ )

| Scattering<br>Angle | Gauss-Legendre |              | Trapezoidal Quadrature |              |
|---------------------|----------------|--------------|------------------------|--------------|
|                     | Intensity      | Polarization | Intensity              | Polarization |
| 0.00                | 27.517848      | 0.000000     | 27.467983              | 0.000000     |
| 5.00                | 21.930220      | -0.001570    | 21.912843              | -0.001516    |
| 10.00               | 13.933973      | -0.003175    | 13.936104              | -0.003217    |
| 15.00               | 9.627869       | -0.002480    | 9.627133               | -0.002501    |
| 20.00               | 6.968873       | -0.000947    | 6.968865               | -0.000810    |
| 25.00               | 5.170425       | 0.003459     | 5.169204               | 0.003331     |
| 30.00               | 3.881988       | 0.009044     | 3.881645               | 0.009103     |
| 35.00               | 2.951191       | 0.017750     | 2.950012               | 0.017596     |
| 40.00               | 2.261300       | 0.028241     | 2.260898               | 0.028135     |
| 45.00               | 1.749777       | 0.042031     | 1.749769               | 0.041972     |
| 50.00               | 1.365778       | 0.058184     | 1.365372               | 0.058073     |
| 55.00               | 1.074961       | 0.077380     | 1.075145               | 0.076950     |
| 60.00               | 0.855332       | 0.098211     | 0.854572               | 0.097857     |
| 65.00               | 0.685607       | 0.120485     | 0.685912               | 0.120480     |
| 70.00               | 0.556637       | 0.143266     | 0.555991               | 0.142673     |
| 75.00               | 0.456271       | 0.164757     | 0.456058               | 0.164959     |
| 80.00               | 0.378865       | 0.184513     | 0.378550               | 0.184058     |
| 85.00               | 0.319032       | 0.199275     | 0.318594               | 0.200081     |
| 90.00               | 0.272443       | 0.210949     | 0.272230               | 0.210609     |
| 95.00               | 0.236955       | 0.213049     | 0.236601               | 0.214309     |
| 100.00              | 0.209769       | 0.210831     | 0.209368               | 0.210396     |
| 105.00              | 0.189428       | 0.195691     | 0.189207               | 0.196939     |
| 110.00              | 0.174989       | 0.174005     | 0.174603               | 0.173860     |
| 115.00              | 0.165090       | 0.140950     | 0.164921               | 0.141842     |
| 120.00              | 0.159906       | 0.100688     | 0.159734               | 0.100845     |
| 125.00              | 0.158751       | 0.054130     | 0.158466               | 0.054847     |
| 130.00              | 0.161664       | 0.005797     | 0.161531               | 0.006187     |
| 135.00              | 0.169249       | -0.042521    | 0.168930               | -0.042707    |
| 140.00              | 0.180715       | -0.087857    | 0.180417               | -0.087401    |
| 145.00              | 0.197115       | -0.128472    | 0.197125               | -0.127842    |
| 150.00              | 0.217899       | -0.165958    | 0.217781               | -0.166240    |
| 155.00              | 0.242010       | -0.198321    | 0.241537               | -0.199711    |
| 160.00              | 0.267969       | -0.227409    | 0.268076               | -0.227614    |
| 165.00              | 0.298947       | -0.207388    | 0.298369               | -0.206938    |
| 170.00              | 0.357341       | -0.167437    | 0.355763               | -0.173064    |
| 175.00              | 0.422300       | -0.079678    | 0.420986               | -0.079102    |
| 180.00              | 0.515393       | 0.000000     | 0.509820               | 0.000000     |

the 5- and 96-point integration. All four figures are for water  $m = 1.33 - 0.00i$  and a particle size range of  $1 \leq \alpha \leq 30$ . The same effect can be seen in Figures A-5 through A-8, which are for the same integrations except that a metal (zinc,  $m = 1.41 - 4.10i$ ) has been used as the material. The smoothing effect and the dominance of the small particles is quite noticeable, particularly in the degree of polarization graphs. Figures A-9 through A-12 compare the results of the integration of the 96-point Gauss-Legendre and the trapezoidal quadrature with  $\Delta \alpha = 0.1$ . A mixture of 50 percent quartz and 50 percent ice particles was used in these graphs. Since the graphs are not too accurately plotted, Table A-1, which gives the values obtained by each quadrature, is included so that a better comparison can be made.

Figure A-13 plots the degree of polarization for water that results from each Gauss-Legendre quadrature. The convergence toward one smooth curve is obvious. Figure A-14 shows the total intensity obtained using the trapezoidal rule and various  $\Delta \alpha$ 's. It should be noted that this curve is insensitive to the integration increment (up to  $\Delta \alpha = 0.5$ ). Figure A-15 plots the degree of polarization that results from the trapezoidal quadrature for various  $\Delta \alpha$ 's. These results agree entirely with those of Dave [7], who used a distribution of the form

$$n(\alpha) = a\alpha^\omega e^{-b\alpha^\gamma}$$

He concludes that  $\Delta \alpha = 0.1$  is the largest size interval that can be used to obtain reliable results. With size intervals of  $\Delta \alpha = 0.5$  and  $1.0$ , ripples appear in some angular regions. For  $\Delta \alpha = 2.0$  pseudo-features appear in the curves. (Compare Figs. A-3 and A-7 with Figs. A-4 and A-8, respectively. Also see Fig. A-13.) Such pseudo-features would tend to invalidate any results from model calculations in which the scattering functions obtained from such a coarse integration were used.

## APPENDIX

### RESULTS OF THE STUDY OF INTEGRATION SCHEMES AND INCREMENTS

As noted previously, two integration schemes were used, a Gauss-Legendre and a trapezoidal quadrature. It was found that large integration increments give higher values of intensity than resulted from the small increments. The polarization curves also differed considerably. For the particle size range of  $1 \leq \alpha \leq 30$ , a 16-point Gauss-Legendre scheme was originally used. However, this was later modified to a 96-point Gauss-Legendre scheme and then to one using either the 16- or 96-point but restricting the integration limits so that  $\alpha_{\max} - \alpha_{\min} = 1.6$  or 9.6, respectively, and changing the upper and lower limits, i. e., for  $1 \leq \alpha \leq 5$  for the 16-point scheme

$$\begin{aligned} \int_1^{1.6} i(m, \alpha, \theta) n(\alpha) d\alpha &+ \int_{1.6}^{3.2} i(m, \alpha, \theta) n(\alpha) d\alpha \\ &+ \int_{3.2}^{4.8} i(m, \alpha, \theta) n(\alpha) d\alpha \\ &+ \int_{4.8}^{5.0} i(m, \alpha, \theta) n(\alpha) d\alpha \end{aligned}$$

For the computer program, to reduce the number of integrations needed, any excess, such as occurs in the fourth term in the above equation, was placed in the first integral. In no case was the integration interval allowed to exceed  $\Delta \alpha = 0.2$ . It should be noted that the Gauss-Legendre schemes do not work well when  $\alpha_{\max}$  is larger than the number of zeros of the Legendre polynomial  $P_n(\cos \theta)$ . In this situation the integration is weighted disproportionately toward the larger particles, negating the smoothing effect the integration should have.

Figures A-1 and A-2 give the results for total radiance for water ( $m = 1.33 - 0.00i$ ) using a 5- and 96-point Gauss-Legendre integration. Figures A-3 and A-4 compare the degree of polarizations that results from



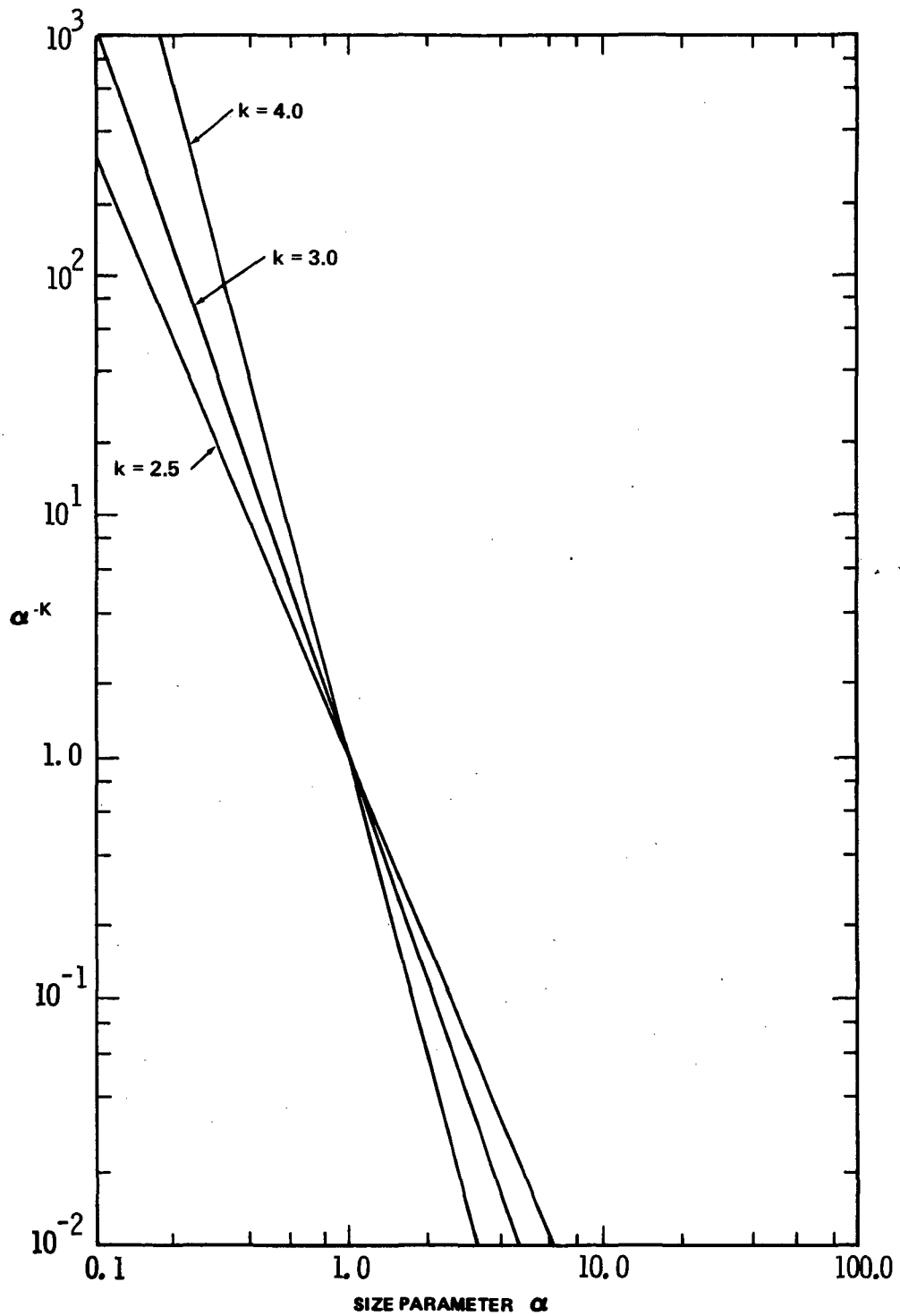


Figure 82. Size distribution for inverse power law.

ZINC  
 $M = 1.41 - 4.101$   
 $1 \leq \alpha \leq 25$

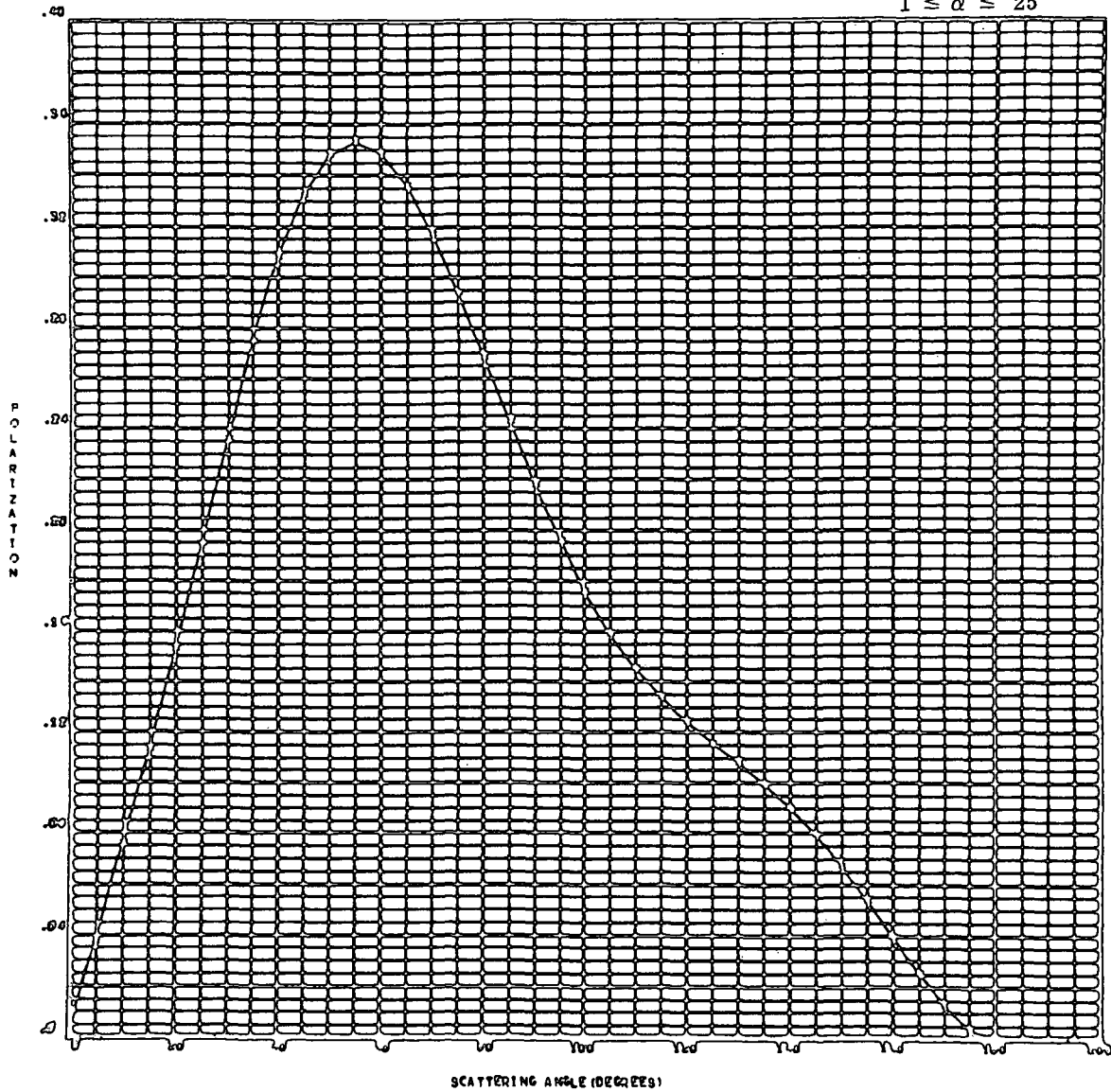


Figure 81. Polarization versus scattering angle  
for zinc with  $1 \leq \alpha \leq 25$ .

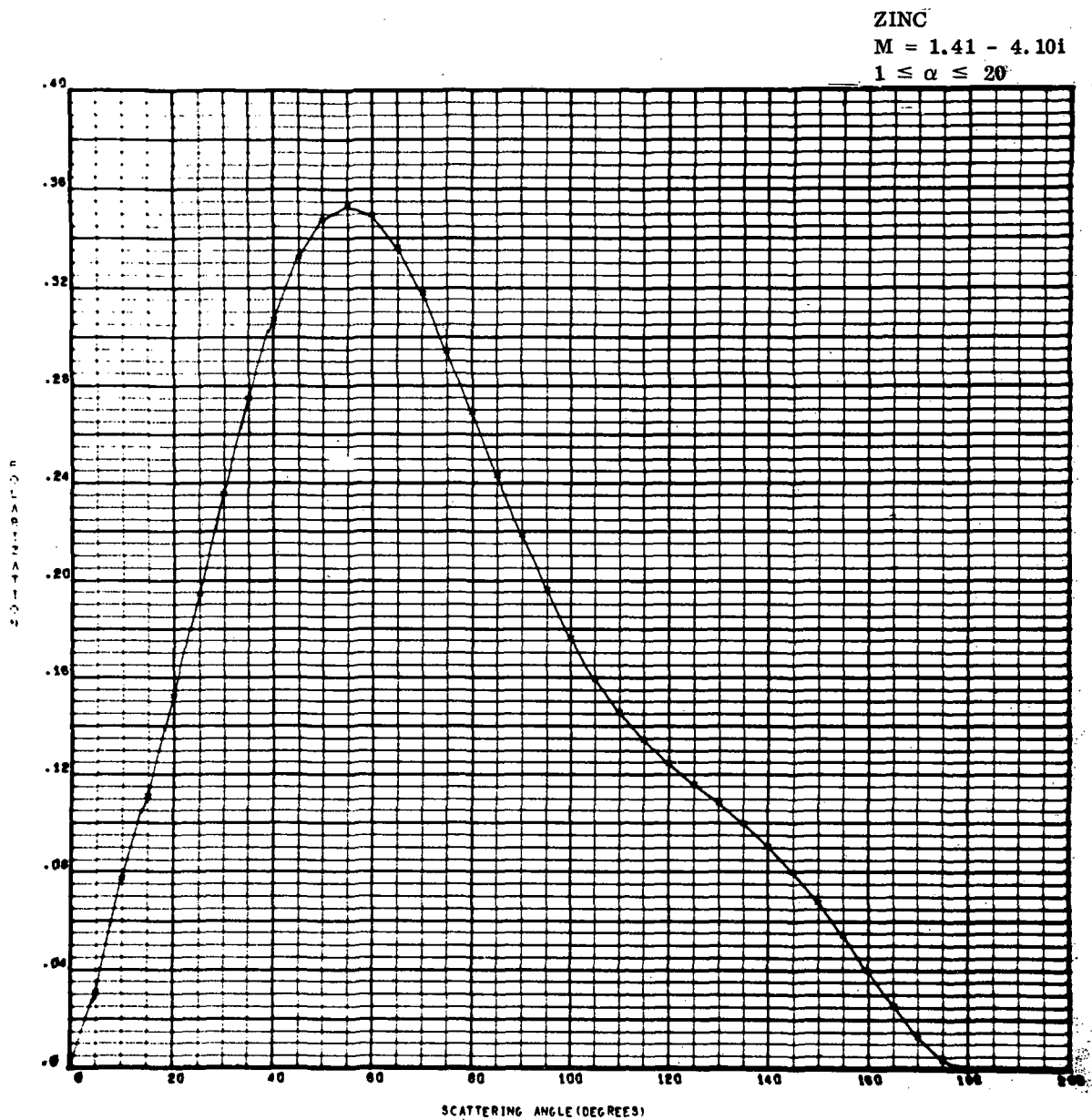


Figure 80. Polarization versus scattering angle  
for zinc with  $1 \leq \alpha \leq 20$ .

ZINC  
 $M = 1.41 - 4.10i$   
 $1 \leq \alpha \leq 15$

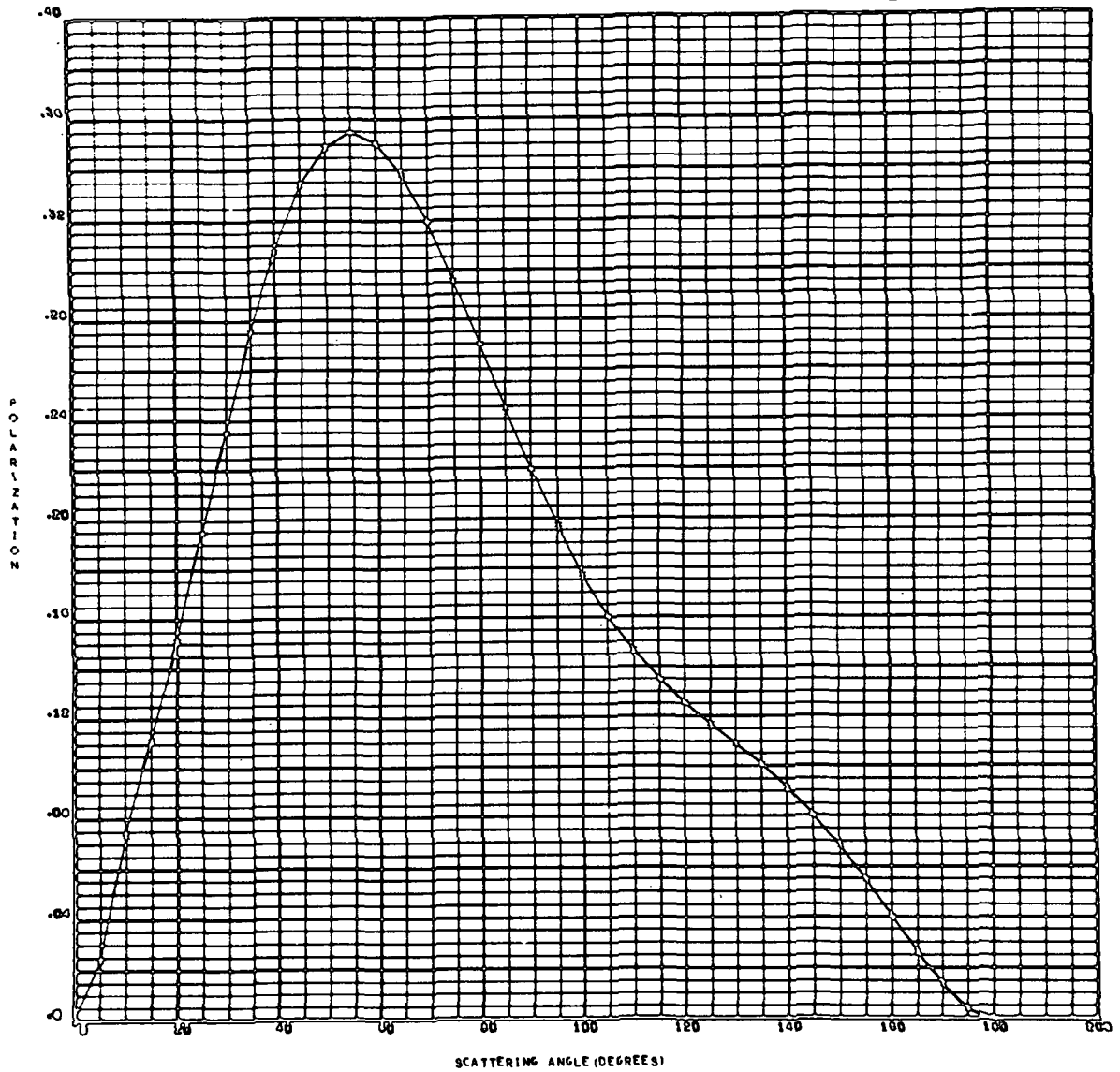


Figure 79. Polarization versus scattering angle  
for zinc with  $1 \leq \alpha \leq 15$ .

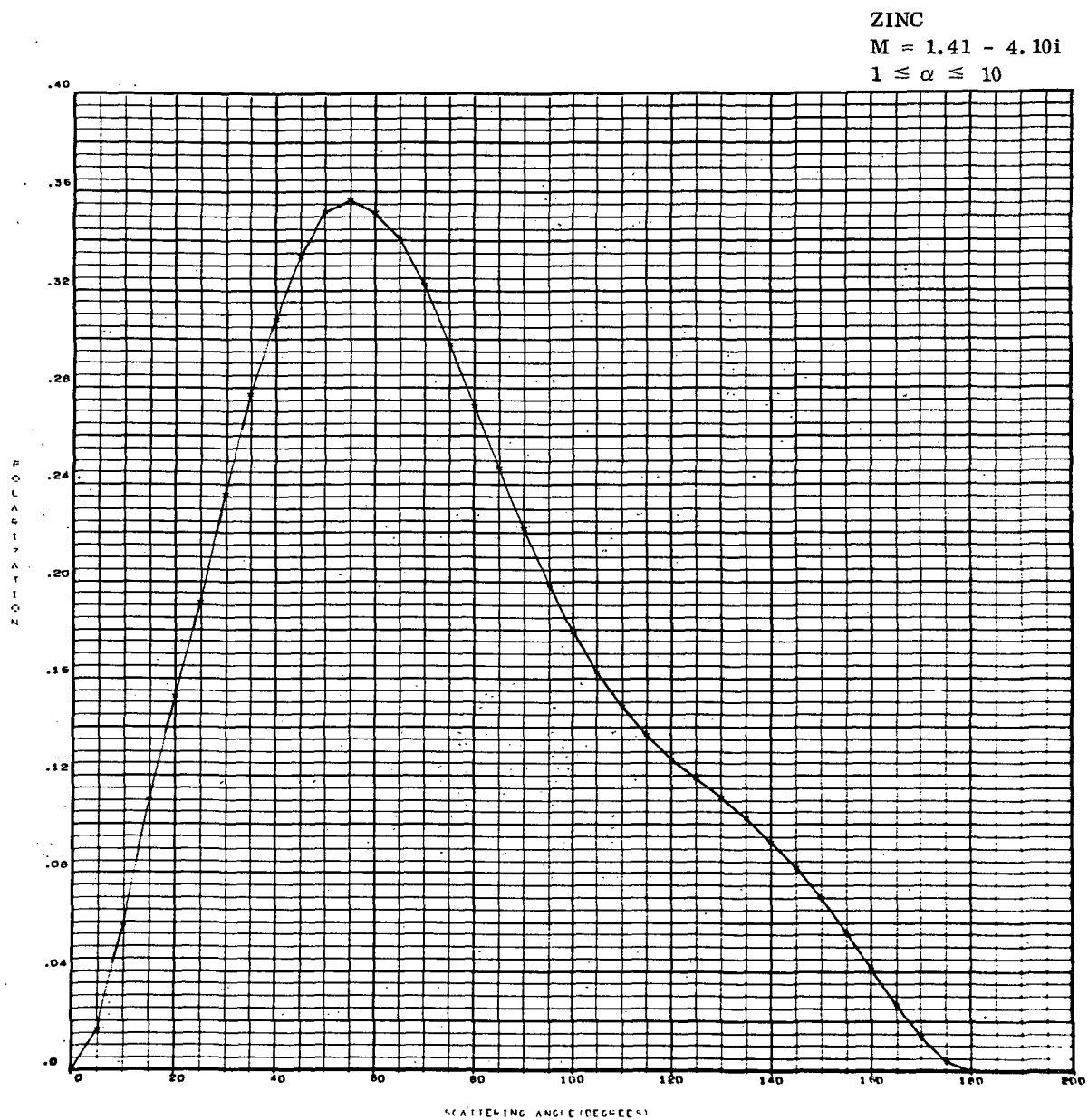


Figure 78. Polarization versus scattering angle  
for zinc with  $1 \leq \alpha \leq 10$ .

ZINC  
 $M = 1.41 - 4.10i$   
 $1 \leq \alpha \leq 5$

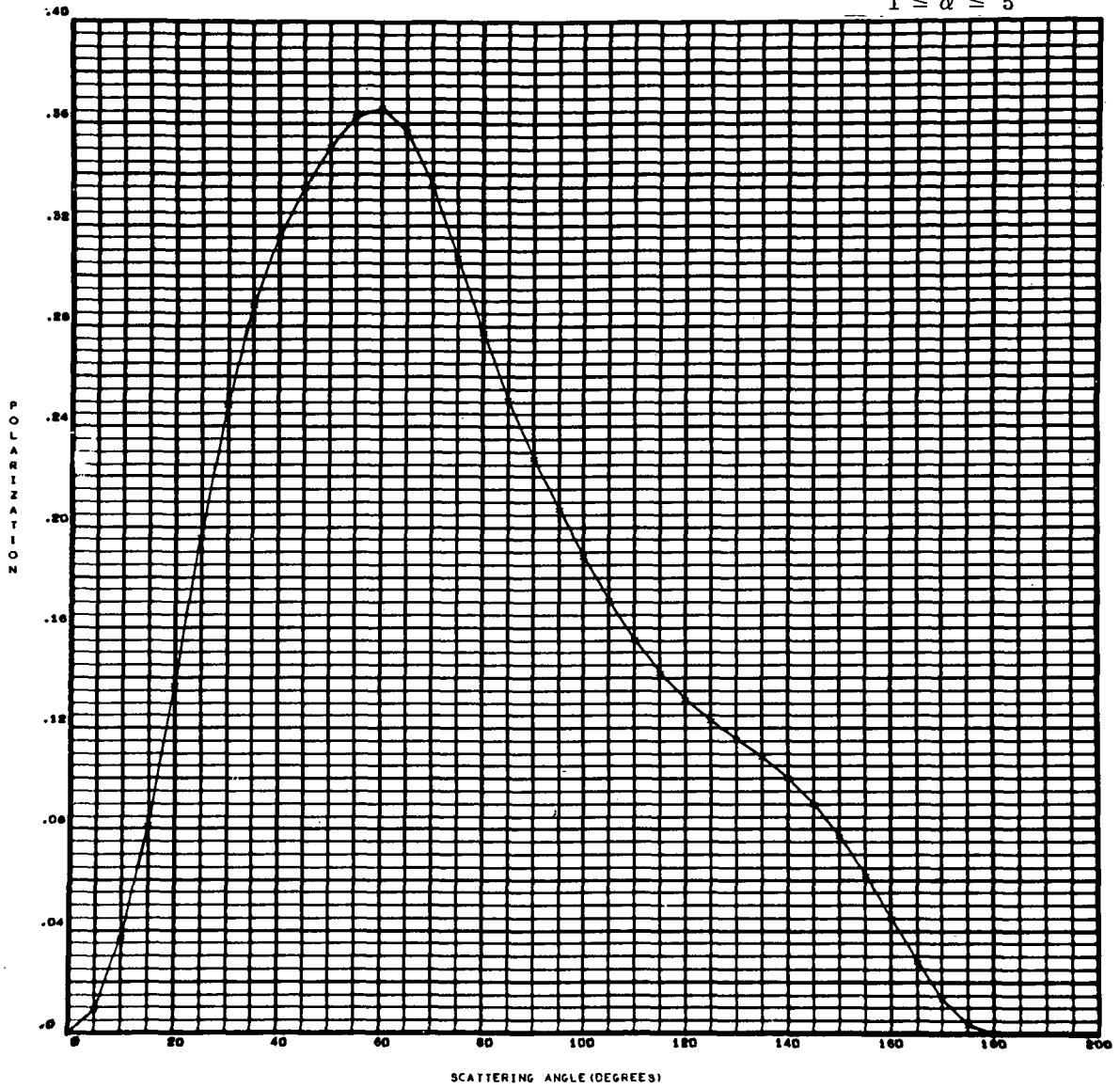


Figure 77. Polarization versus scattering angle  
for zinc with  $1 \leq \alpha \leq 5$ .

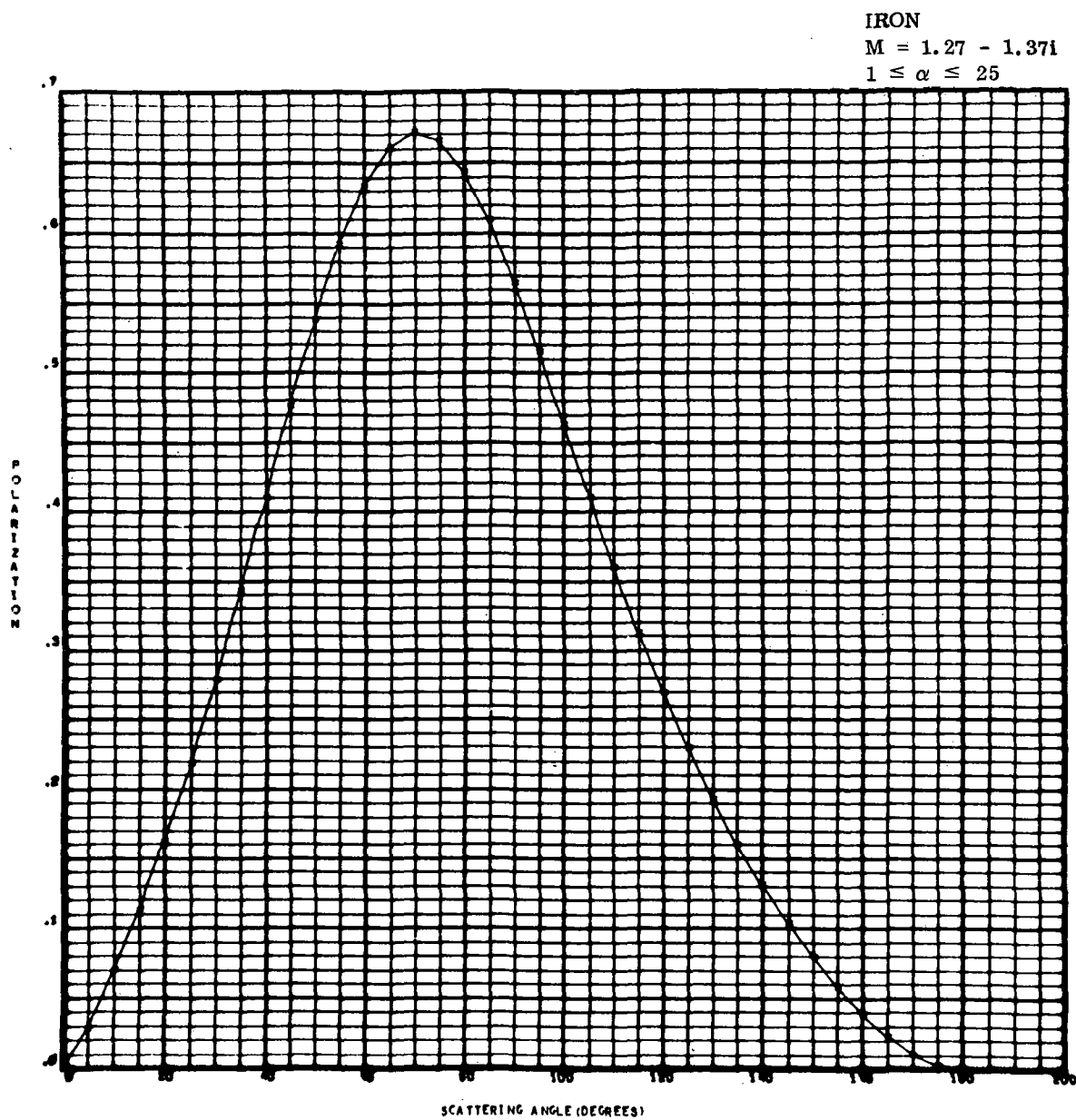


Figure 76. Polarization versus scattering angle  
for iron with  $1 \leq \alpha \leq 25$ .

IRON  
 $M = 1.27 - 1.37i$   
 $1 \leq \alpha \leq 20$

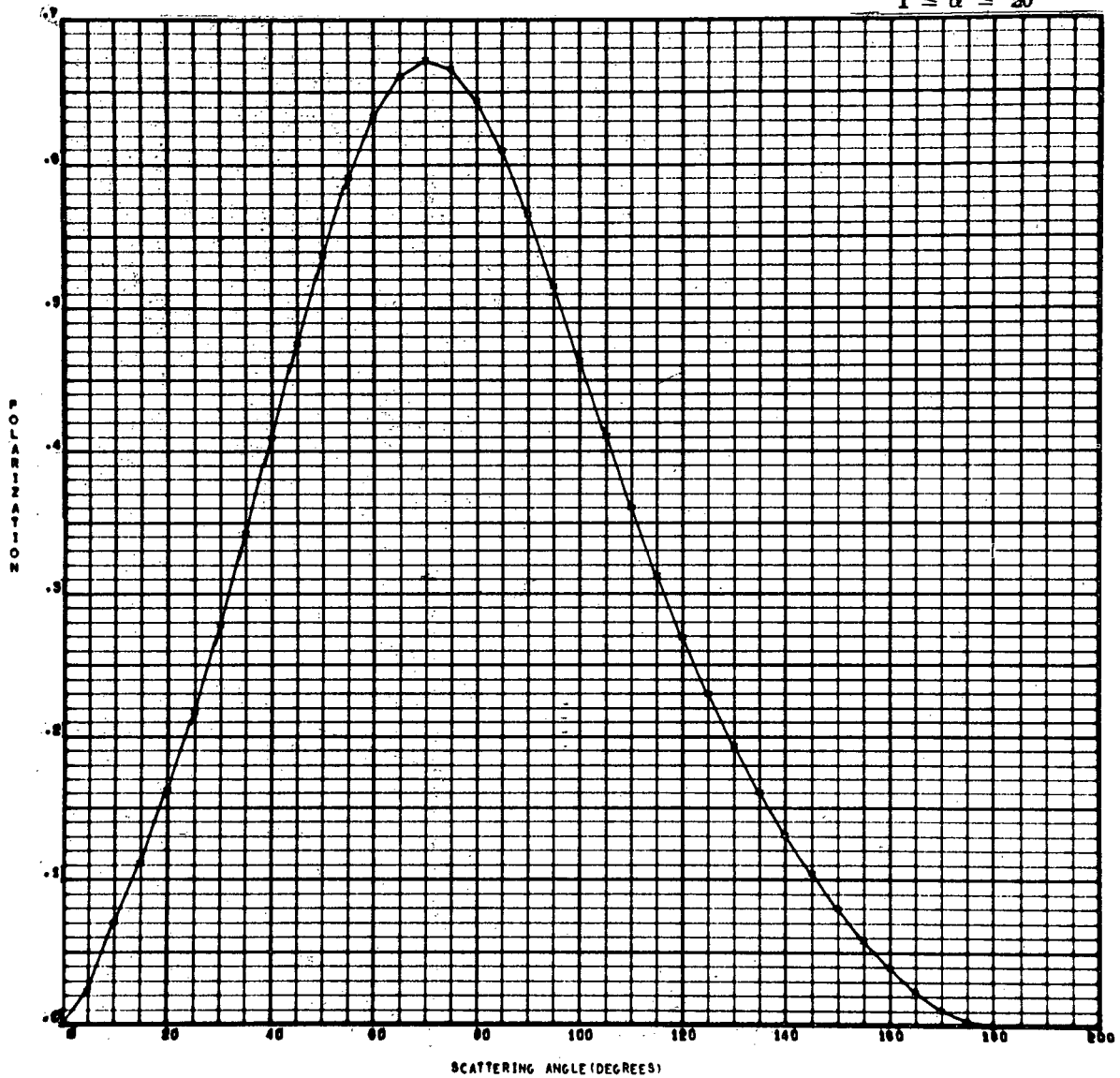


Figure 75. Polarization versus scattering angle  
for iron with  $1 \leq \alpha \leq 20$ .



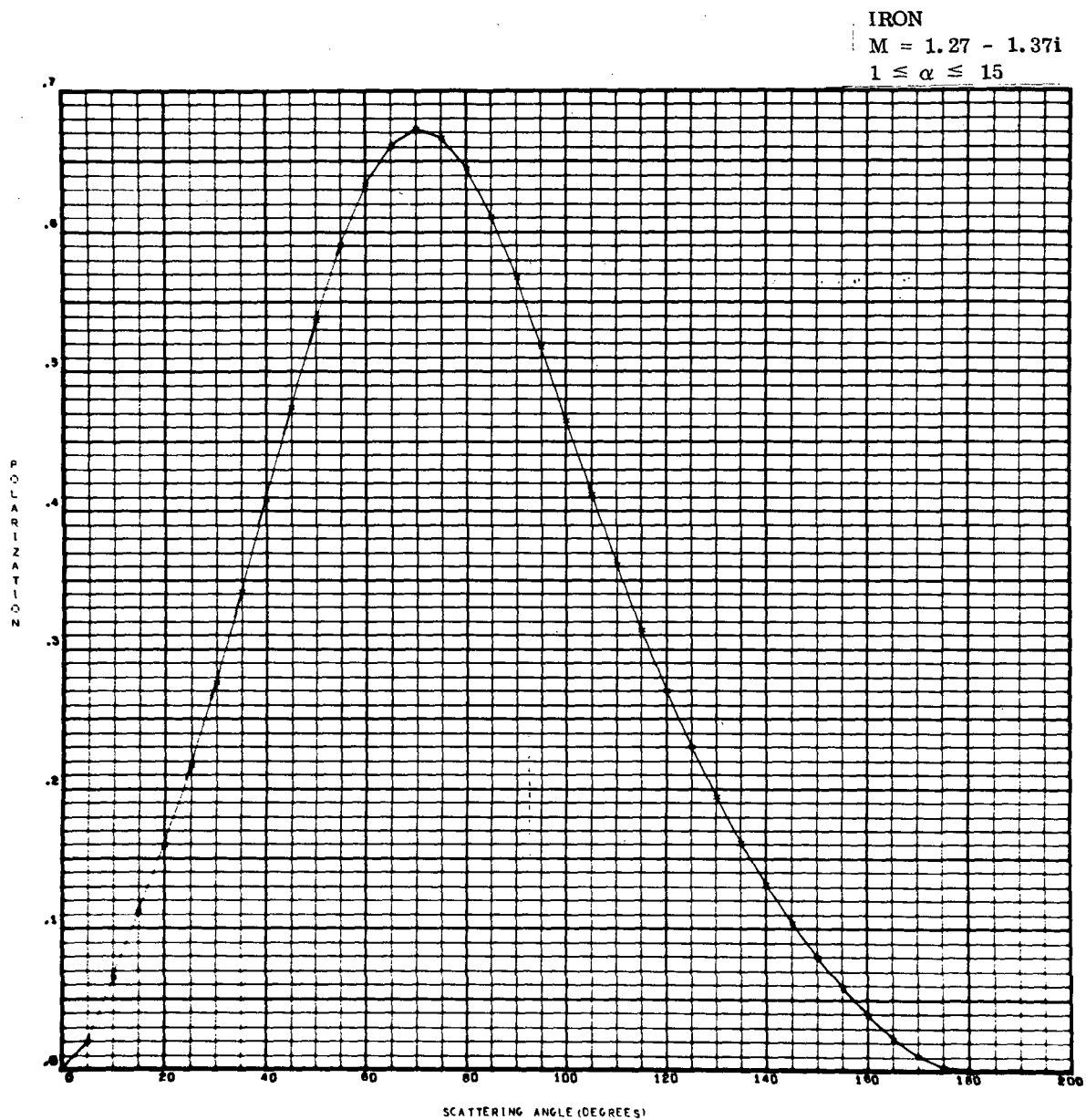


Figure 74. Polarization versus scattering angle  
for iron with  $1 \leq \alpha \leq 15$ .

IRON  
 $M = 1.27 - 1.37i$   
 $1 \leq \alpha \leq 10$

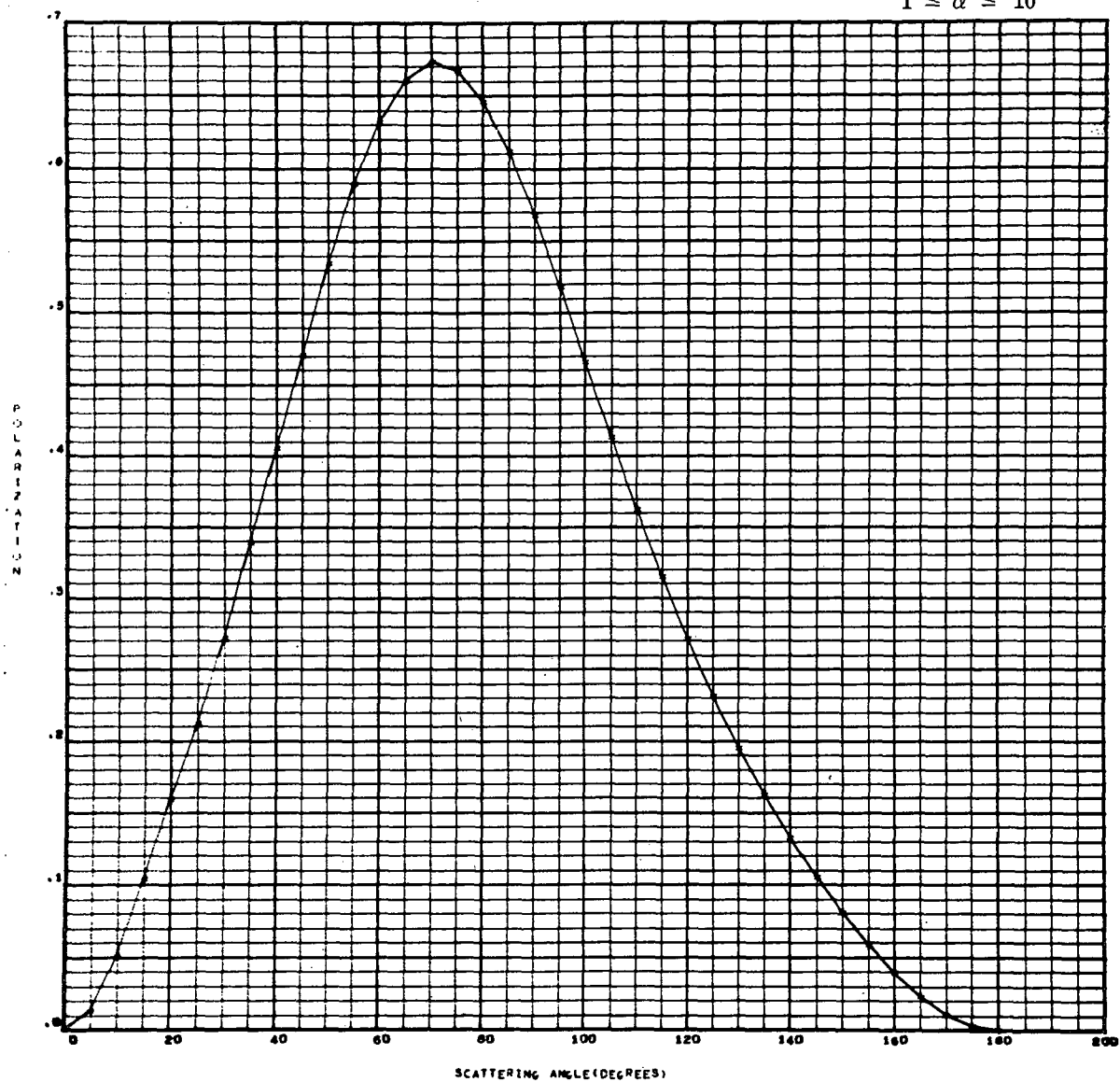


Figure 73. Polarization versus scattering angle  
for iron with  $1 \leq \alpha \leq 10$ .

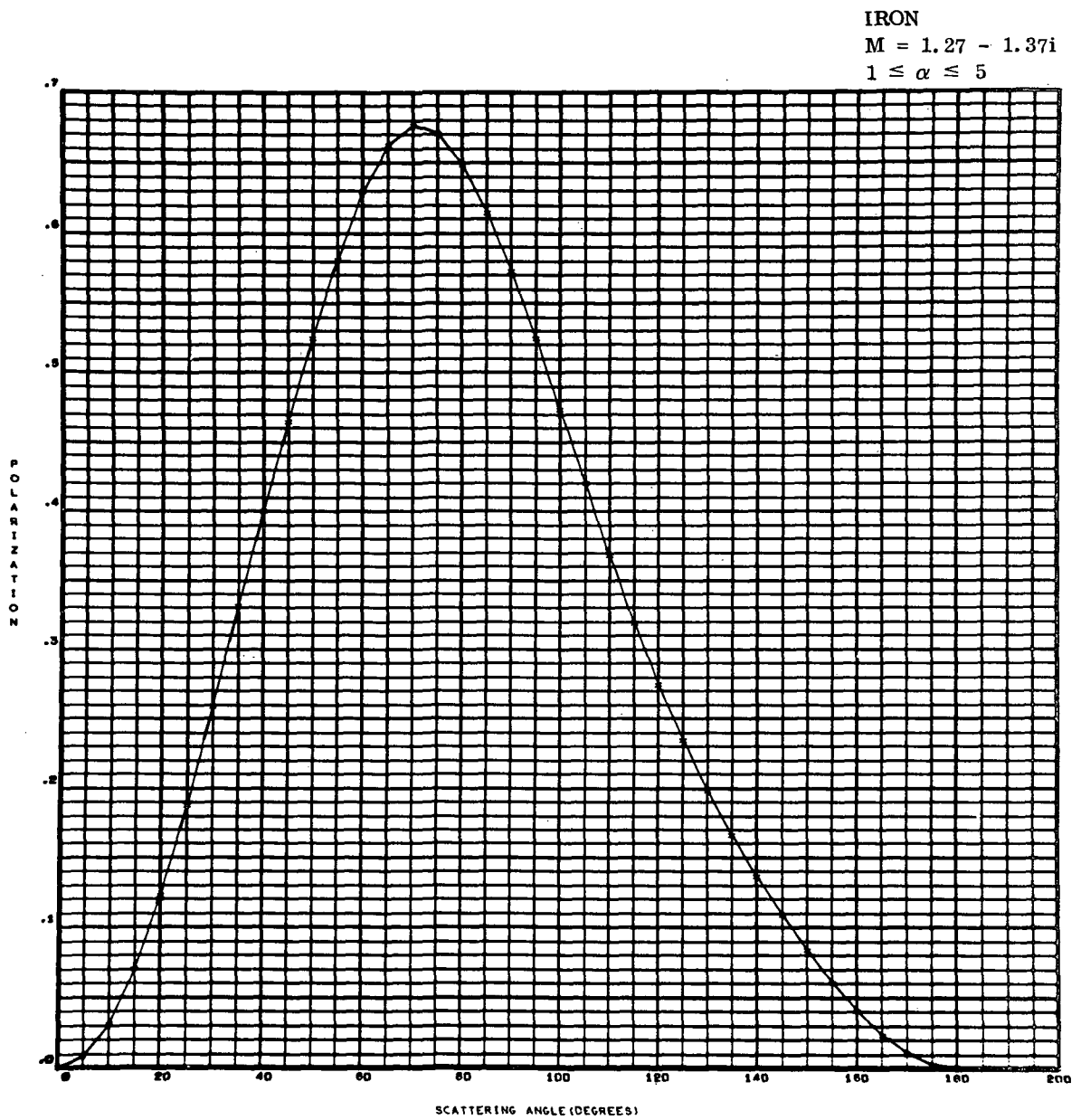


Figure 72. Polarization versus scattering angle  
for iron with  $1 \leq \alpha \leq 5$ .

GRAPHITE  
 $M = 1.59 - 0.66i$   
 $1 \leq \alpha \leq 25$

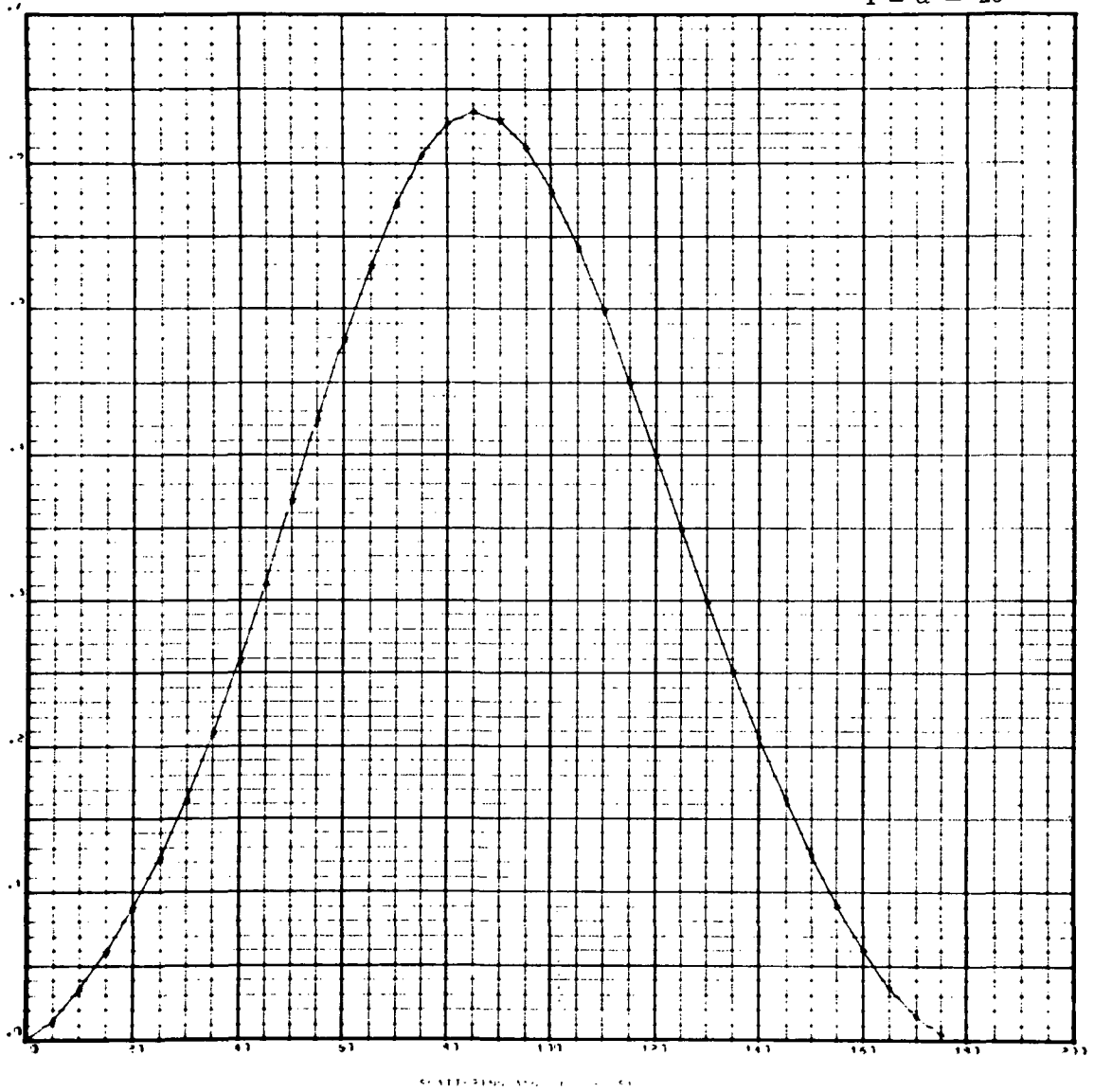


Figure 71. Polarization versus scattering angle  
for graphite with  $1 \leq \alpha \leq 25$ .

GRAPHITE

$M = 1.59 - 0.66i$

$1 \leq \alpha \leq 20$

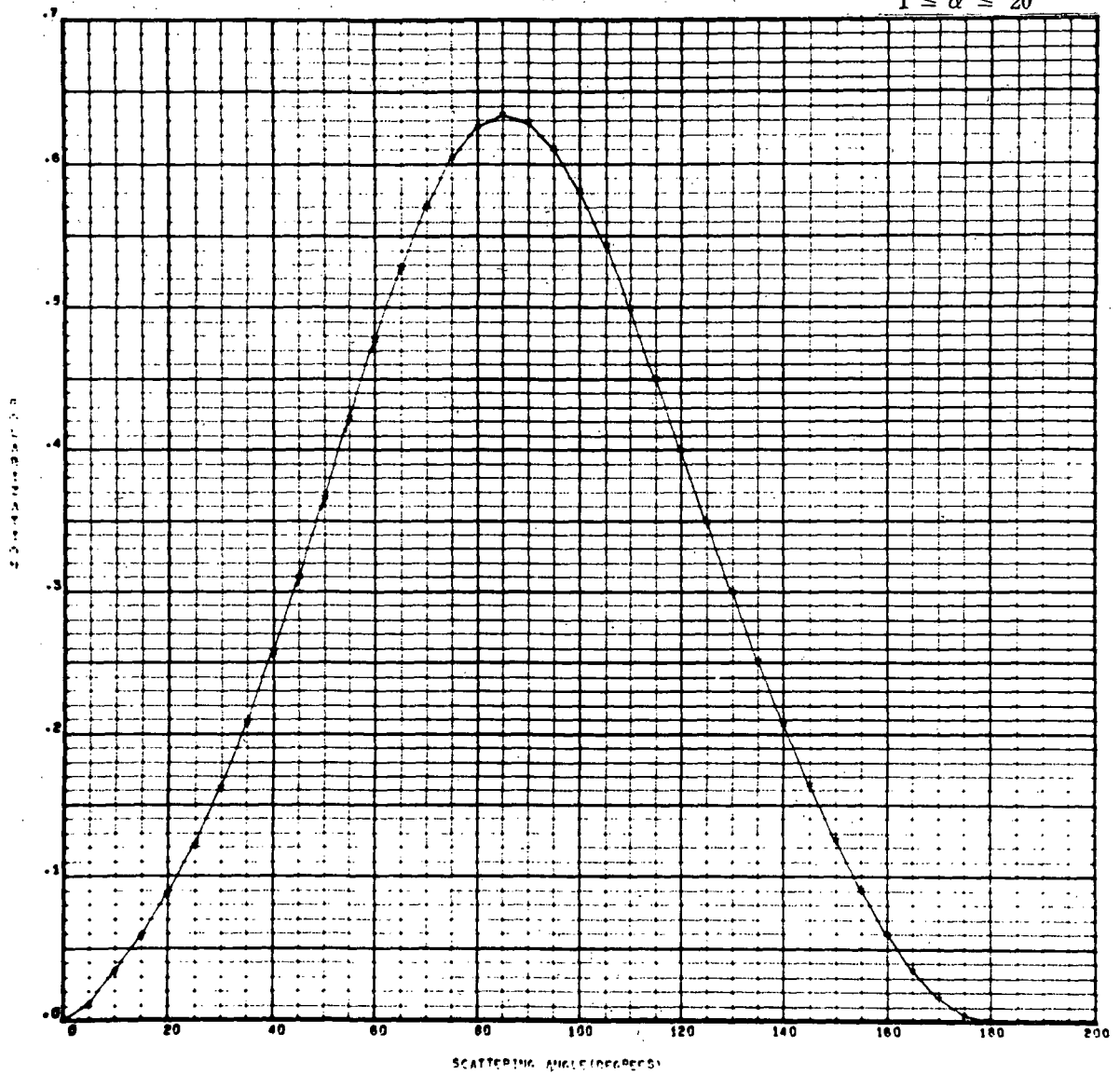


Figure 70. Polarization versus scattering angle  
for graphite with  $1 \leq \alpha \leq 20$ .

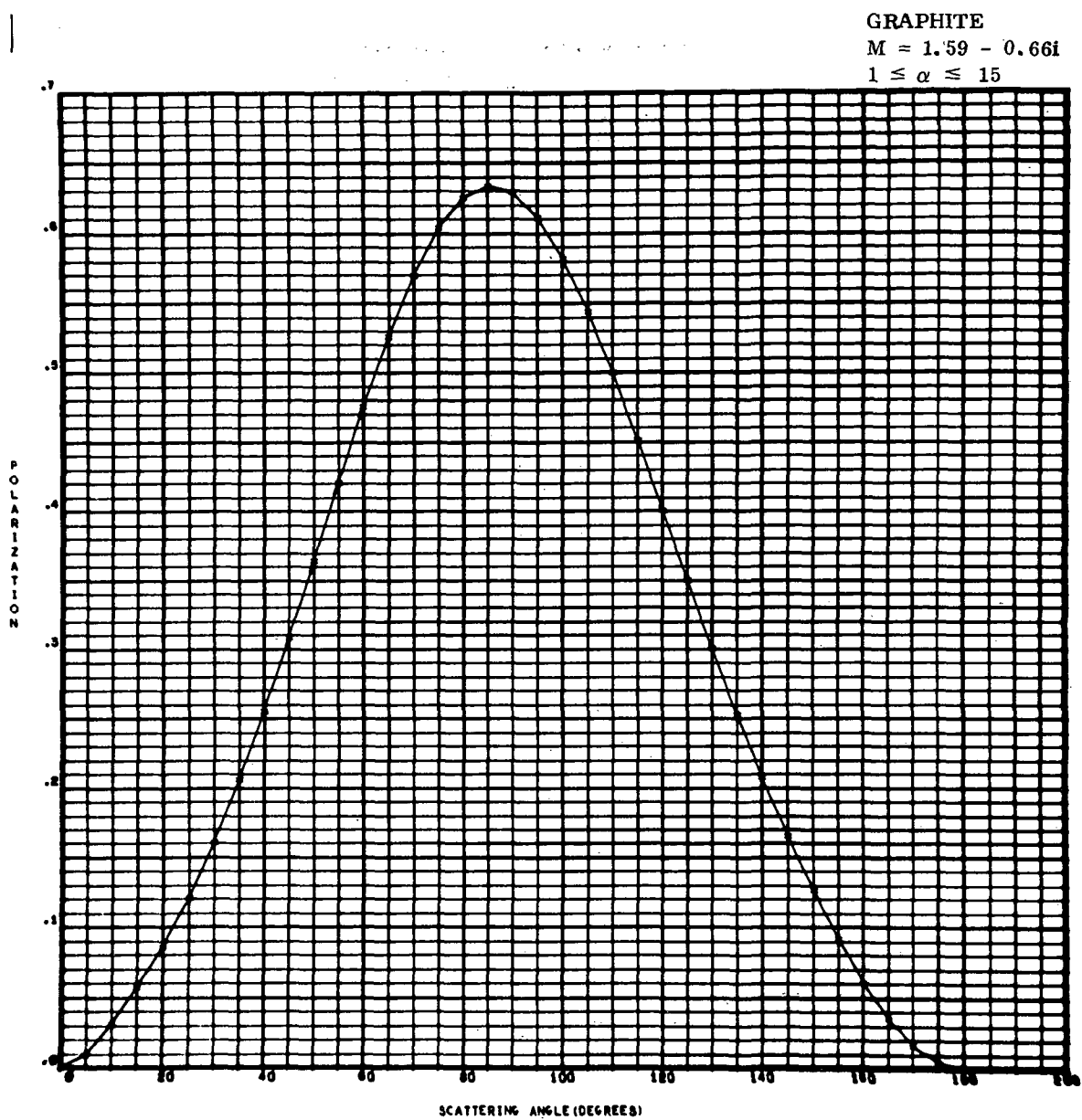


Figure 69. Polarization versus scattering angle  
for graphite with  $1 \leq \alpha \leq 15$ .

GRAPHITE  
 $M = 1.59 - 0.661$   
 $1 \leq \alpha \leq 10$

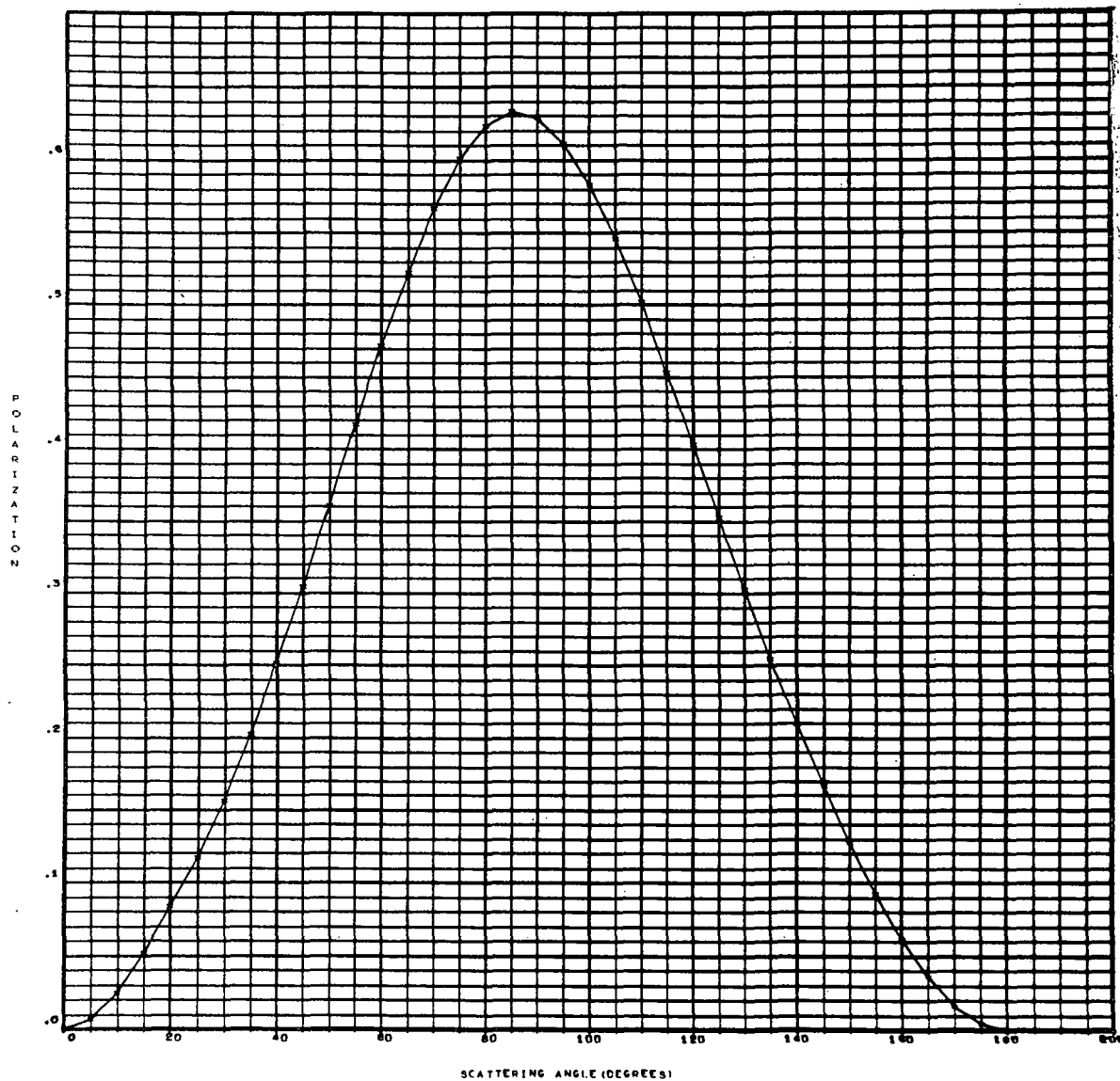


Figure 68. Polarization versus scattering angle  
for graphite with  $1 \leq \alpha \leq 10$ .

GRAPHITE  
 $M = 1.59 - 0.661$   
 $1 \leq \alpha \leq 5$

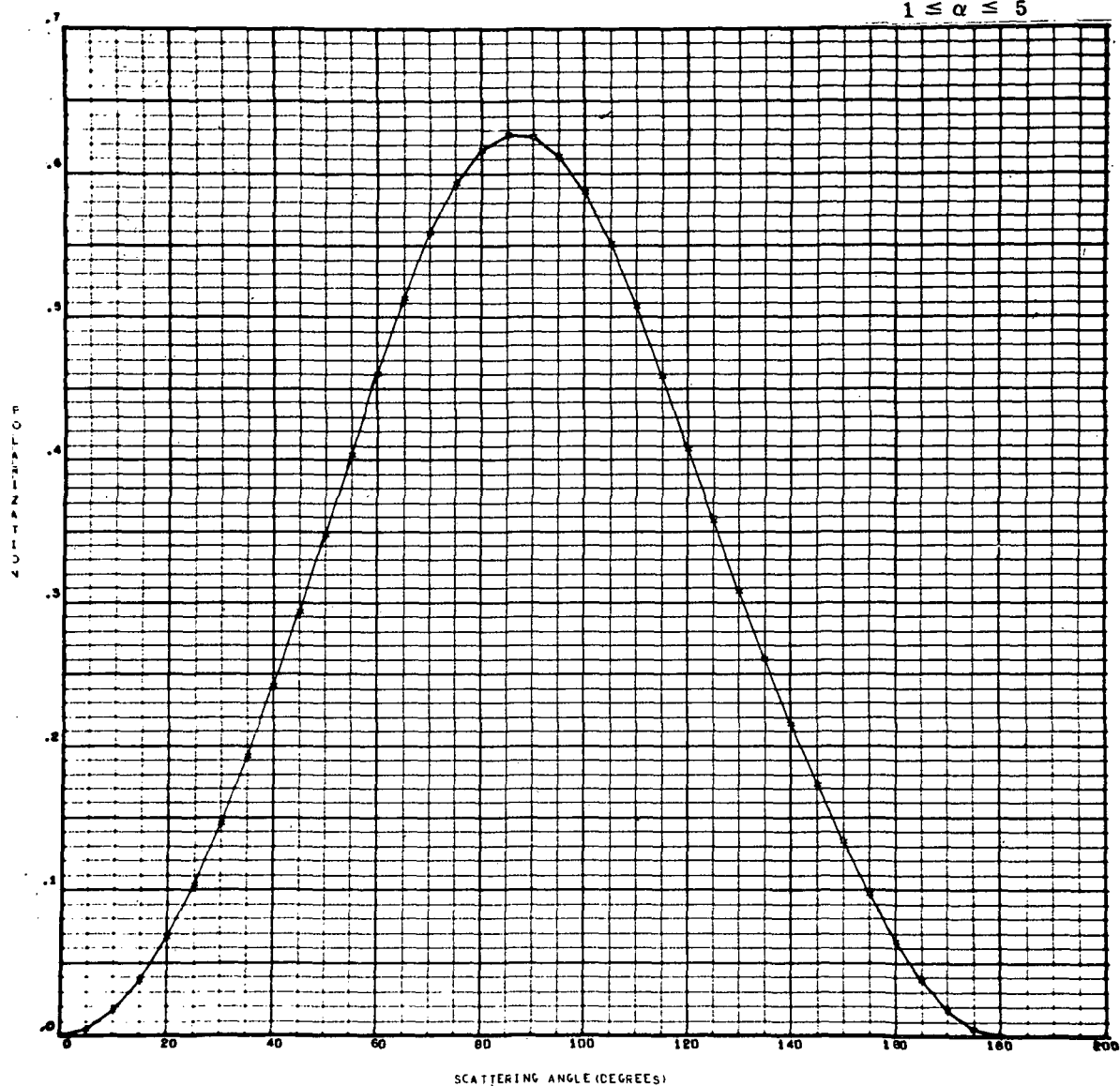


Figure 67. Polarization versus scattering angle  
for graphite with  $1 \leq \alpha \leq 5$ .



WATER (ICE II)  
 $M = 1.33 - 0.10i$   
 $1 \leq \alpha \leq 25$

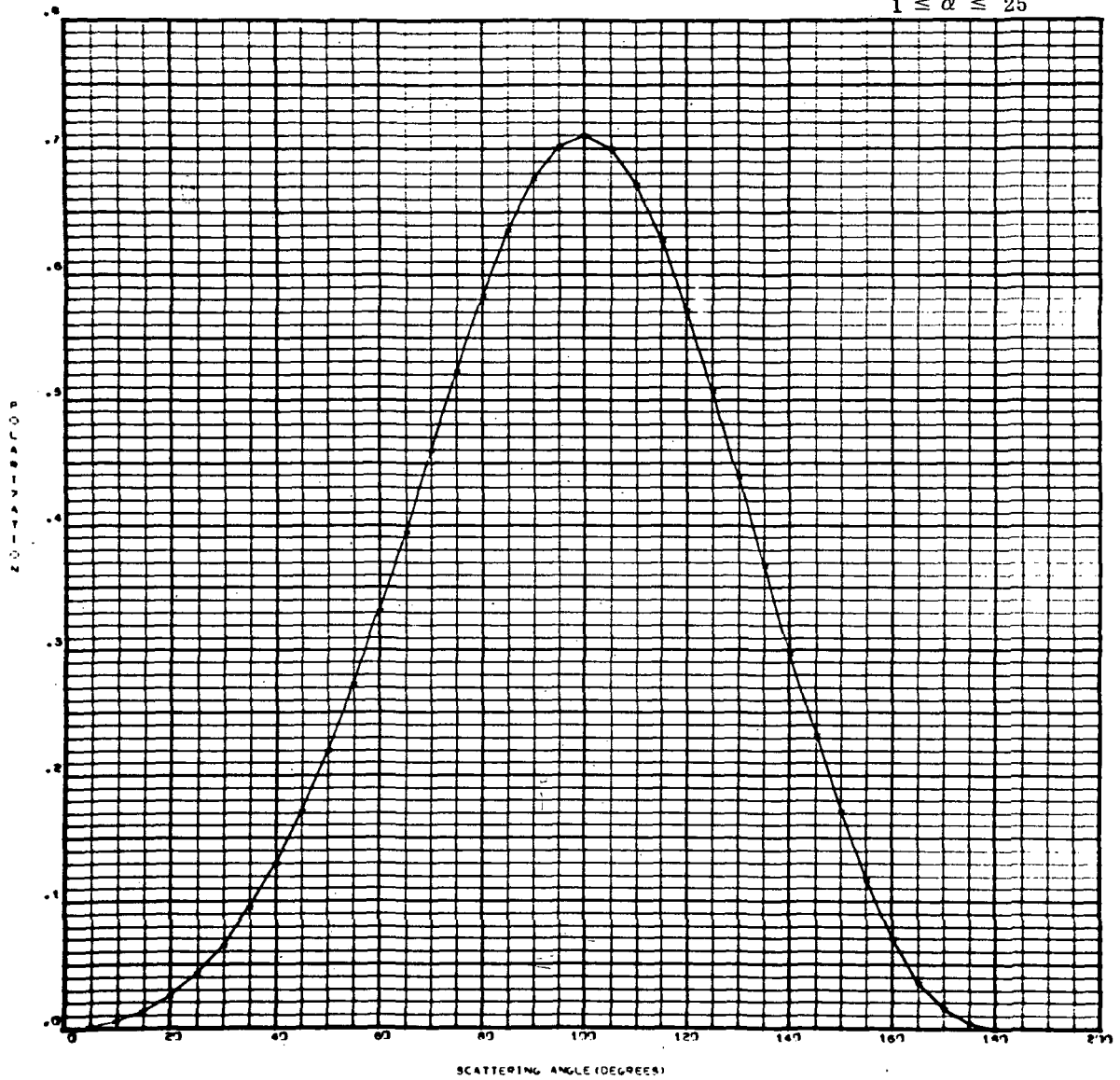


Figure 66. Polarization versus scattering angle  
for water (ice II) with  $1 \leq \alpha \leq 25$ .

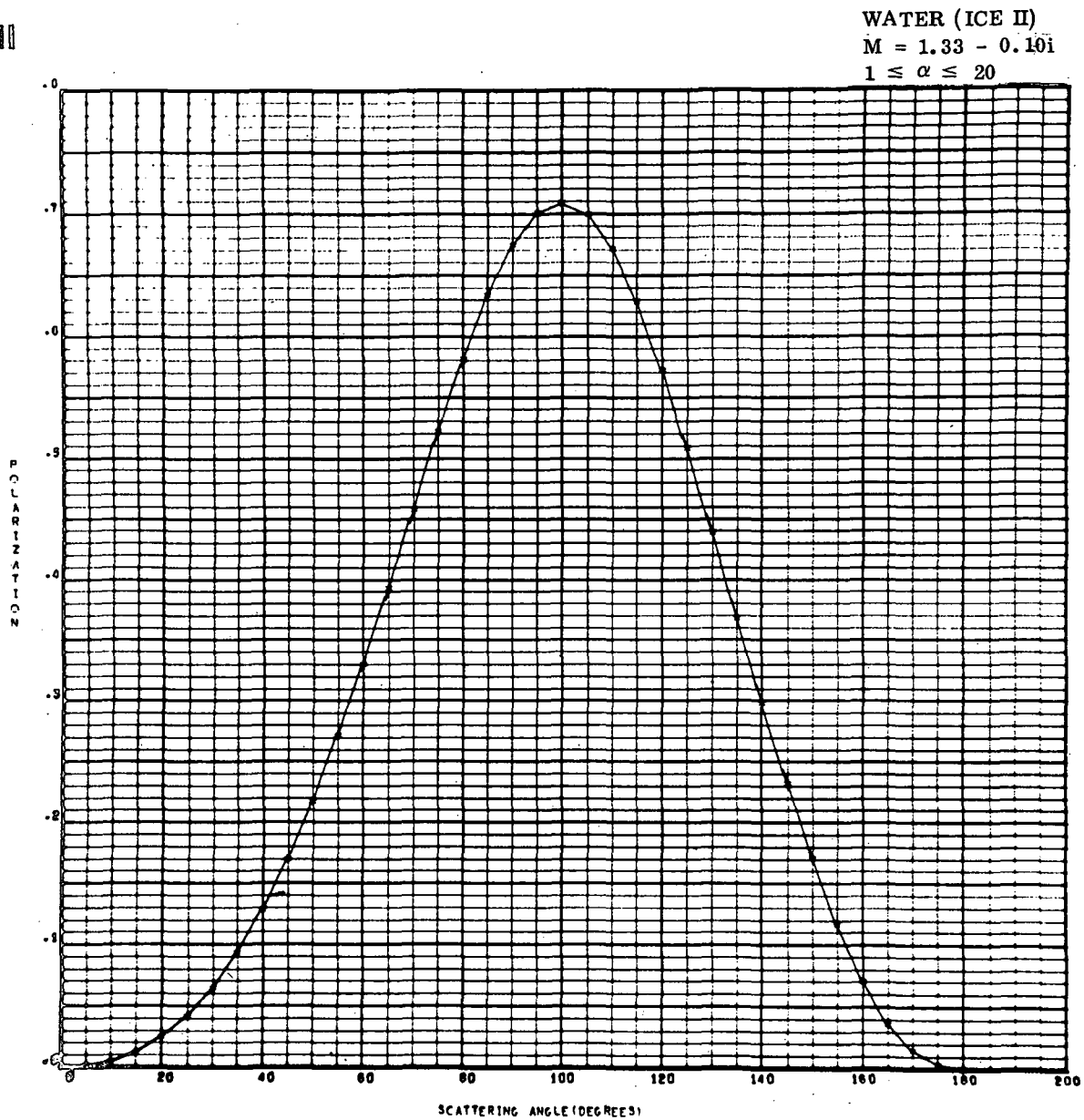


Figure 65. Polarization versus scattering angle  
for water (ice II) with  $1 \leq \alpha \leq 20$ .

WATER (ICE II)  
 $M = 1.33 - 0.10i$   
 $1 \leq \alpha \leq 15$

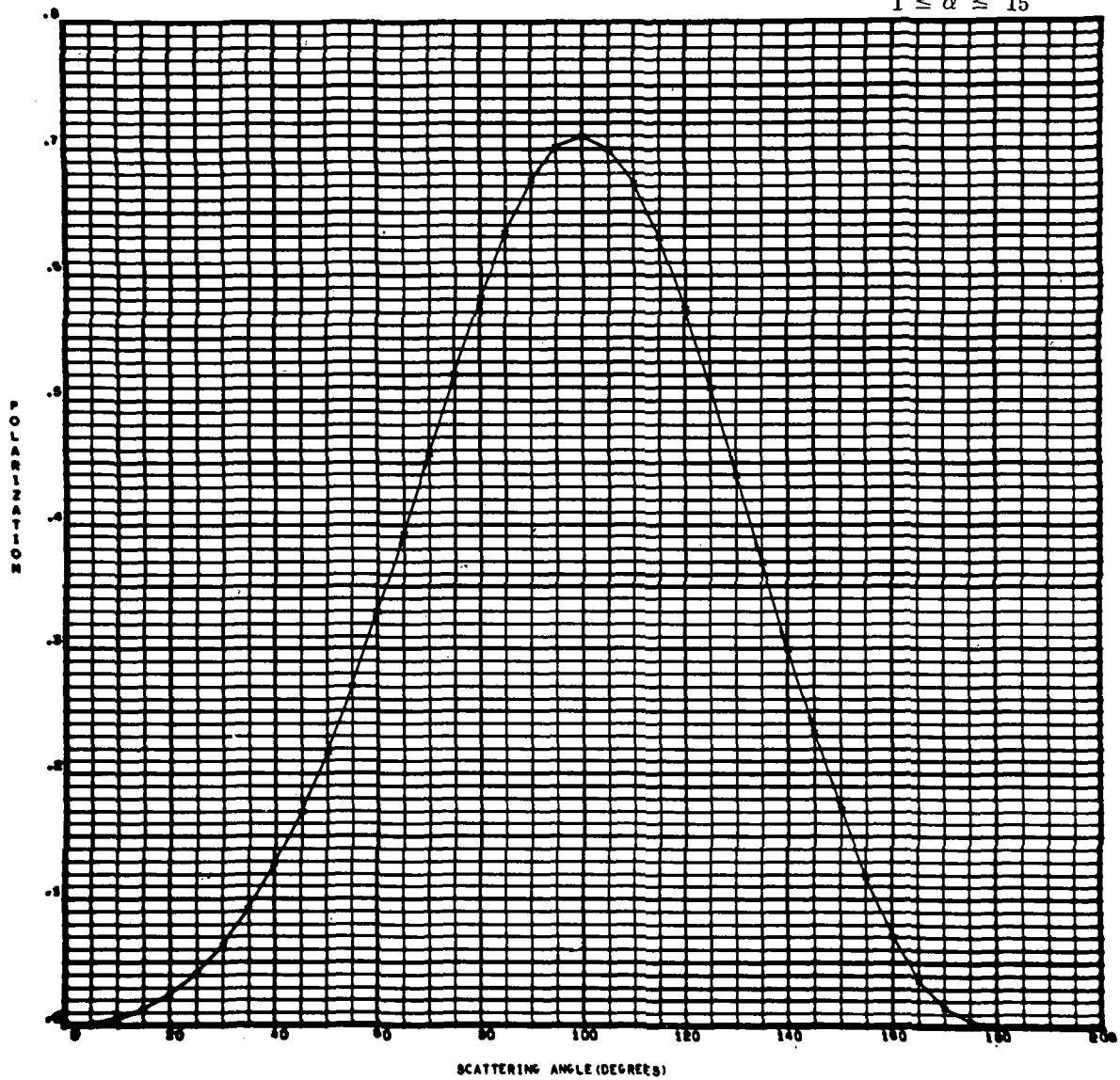


Figure 64. Polarization versus scattering angle  
for water (ice II) with  $1 \leq \alpha \leq 15$ .

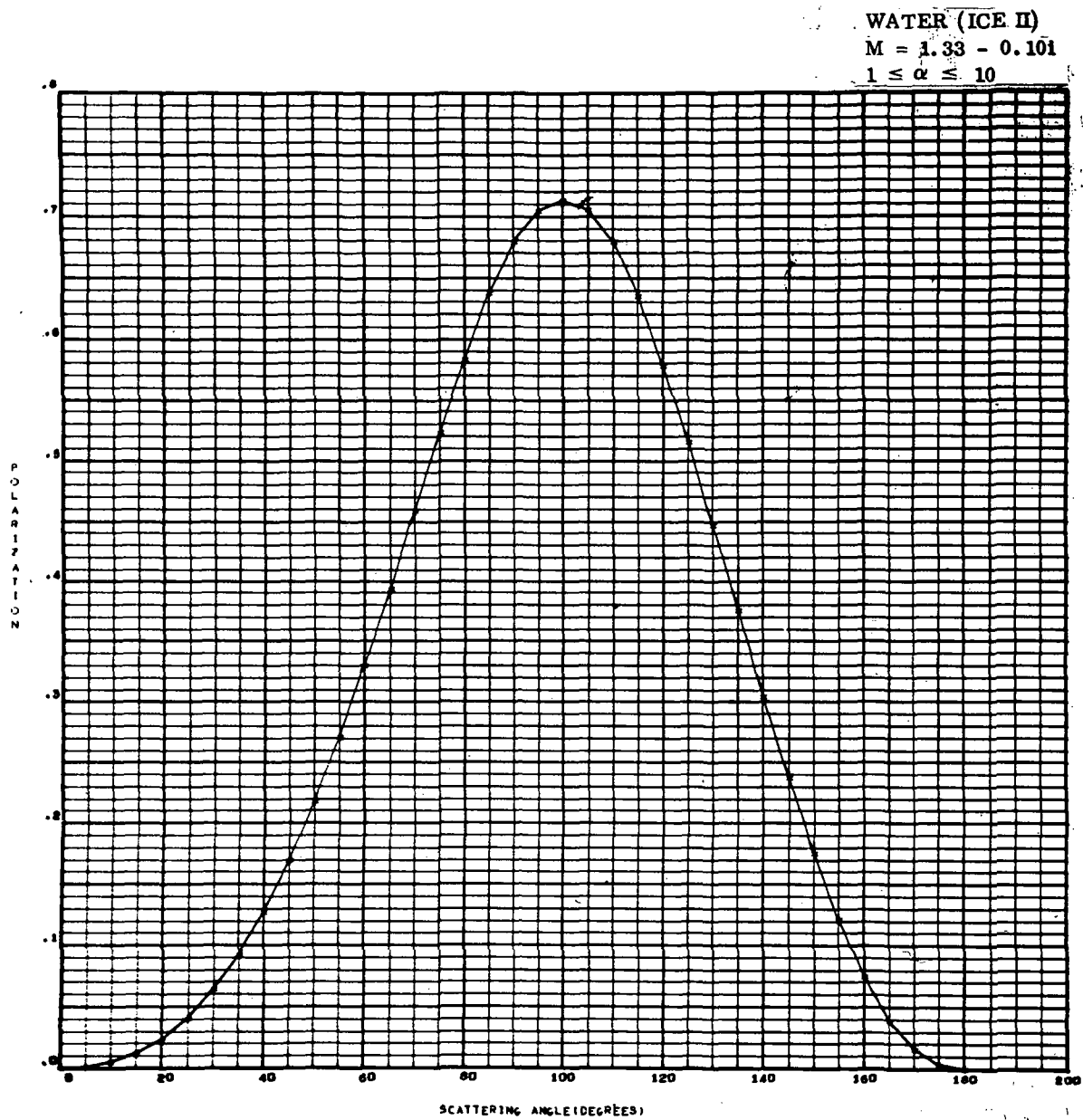


Figure 63. Polarization versus scattering angle  
for water (ice II) with  $1 \leq \alpha \leq 10$ .

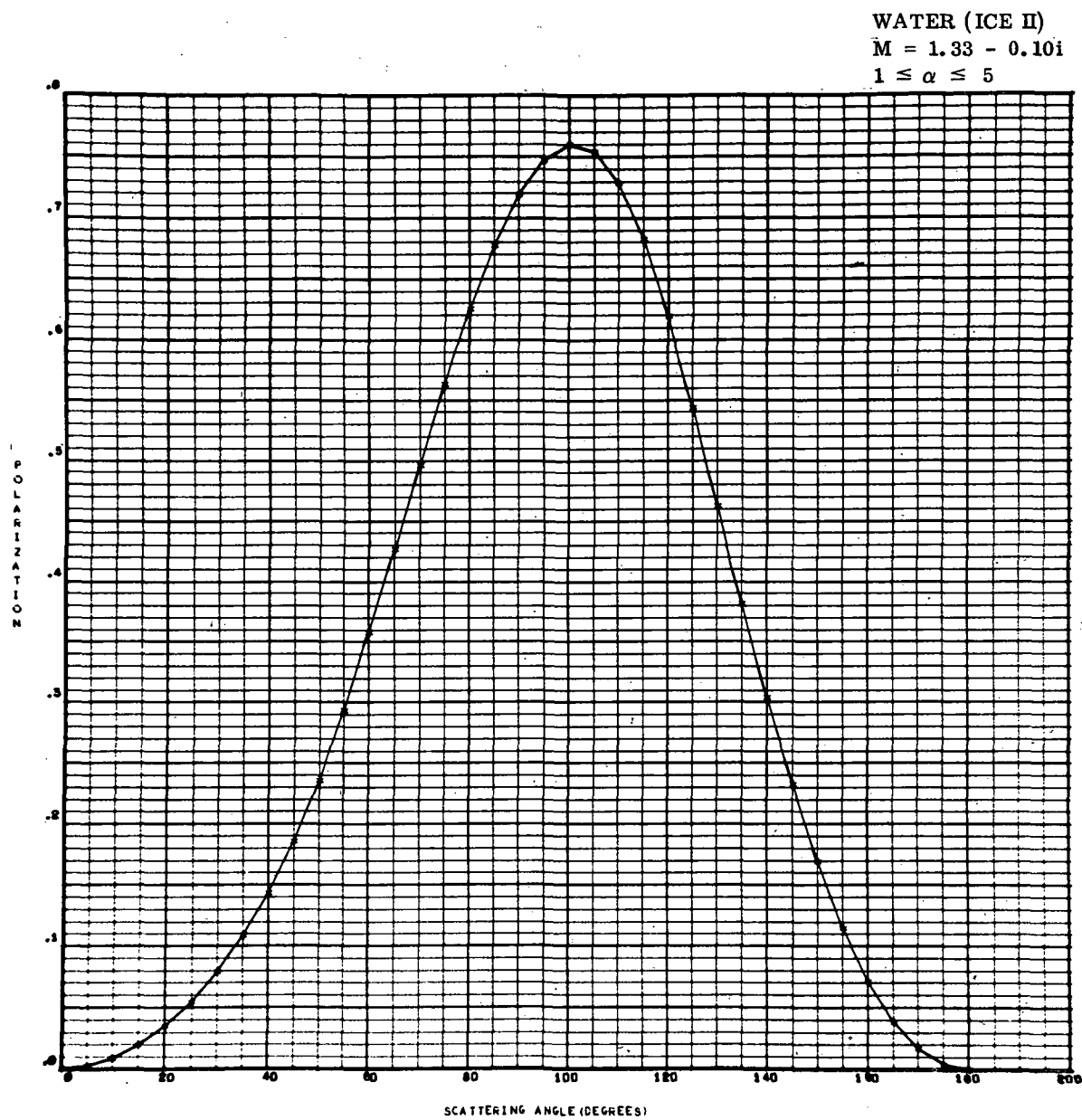


Figure 62. Polarization versus scattering angle  
for water (ice II) with  $1 \leq \alpha \leq 5$ .

WATER (ICE I)  
 $M = 1.33 - 0.05i$   
 $1 \leq \alpha \leq 25$

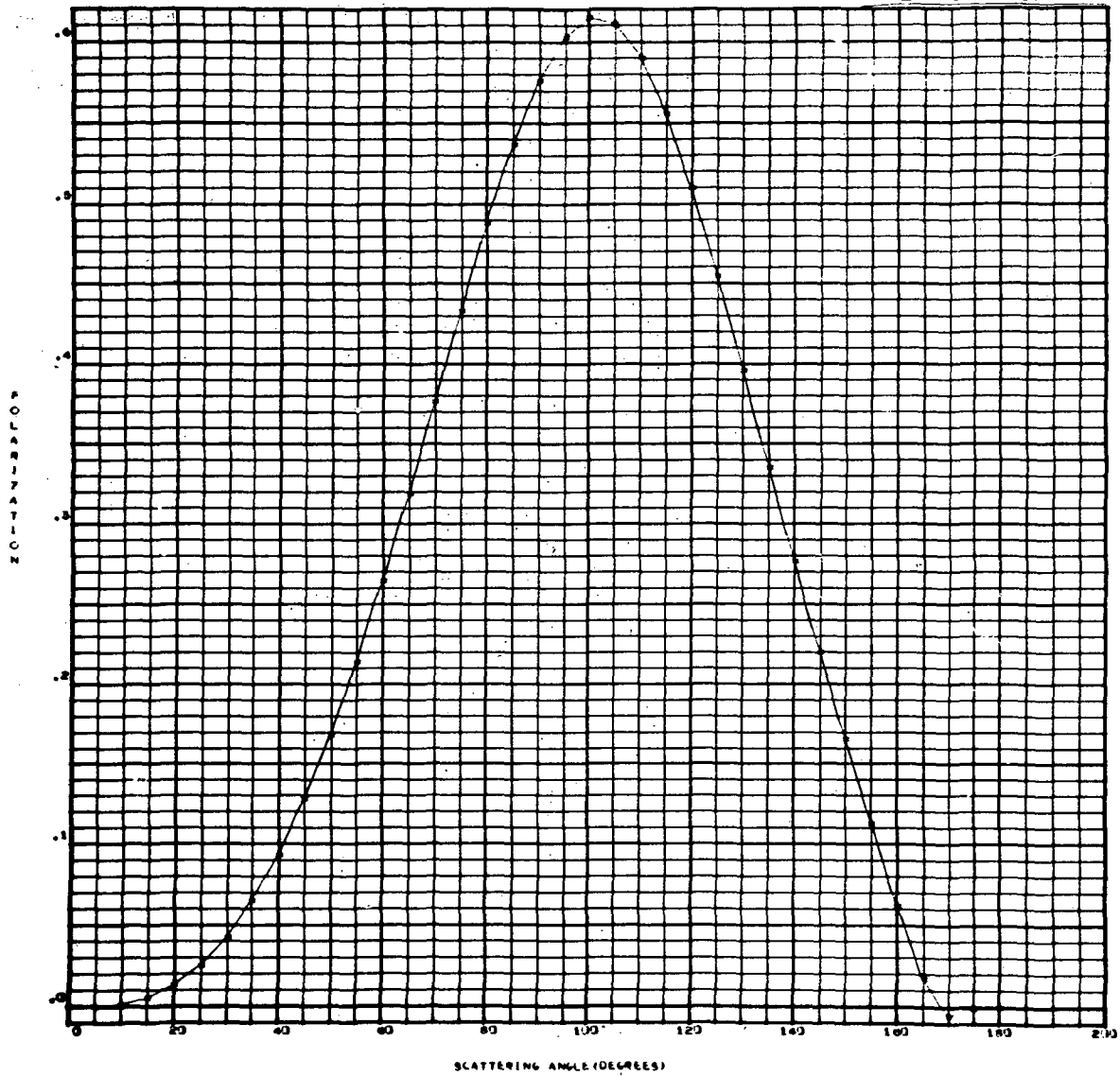


Figure 61. Polarization versus scattering angle  
for water (ice I) with  $1 \leq \alpha \leq 25$ .

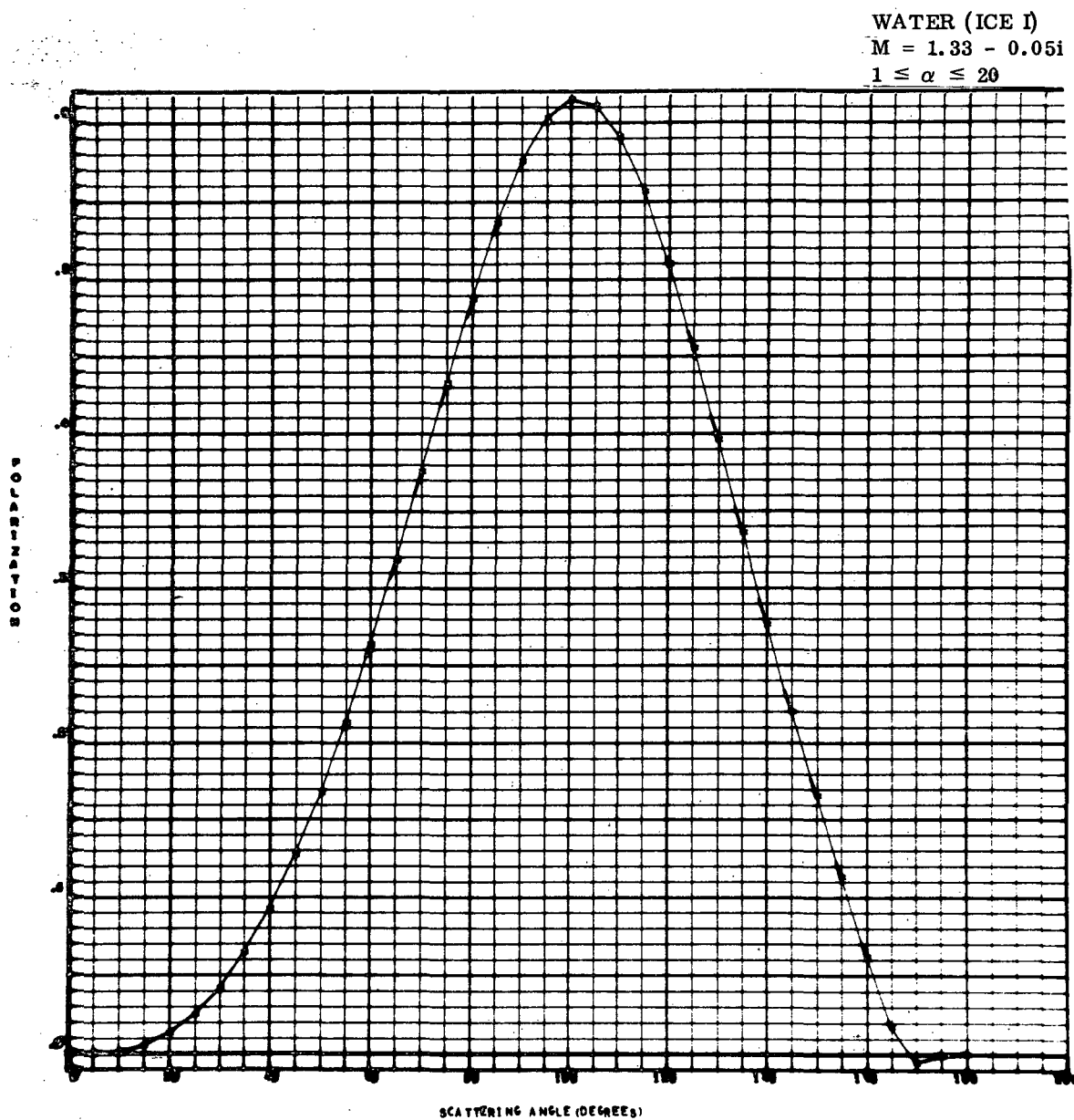


Figure 60. Polarization versus scattering angle  
for water (ice I) with  $1 \leq \alpha \leq 20$ .

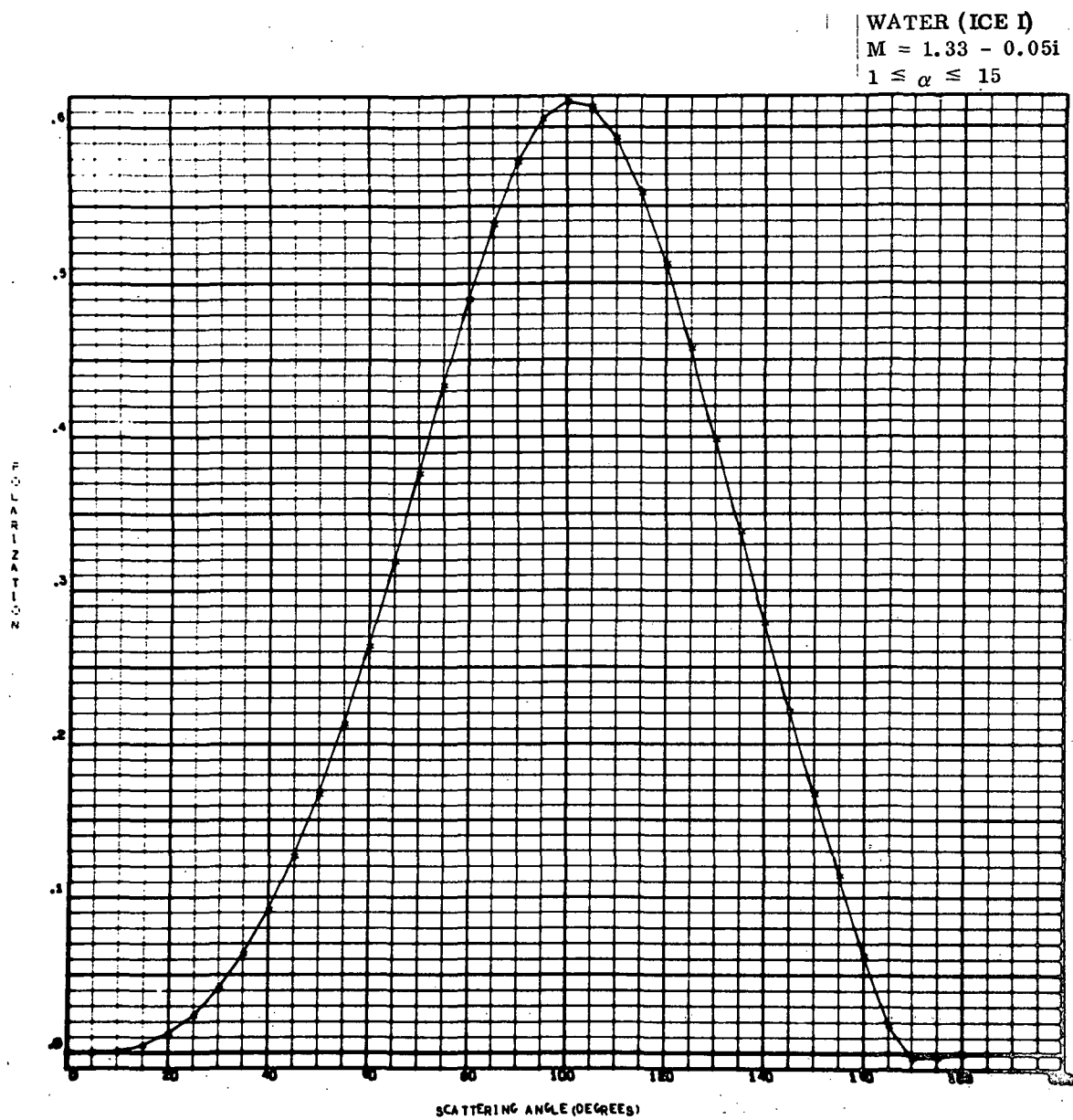


Figure 59. Polarization versus scattering angle  
for water (ice I) with  $1 \leq \alpha \leq 15$ .



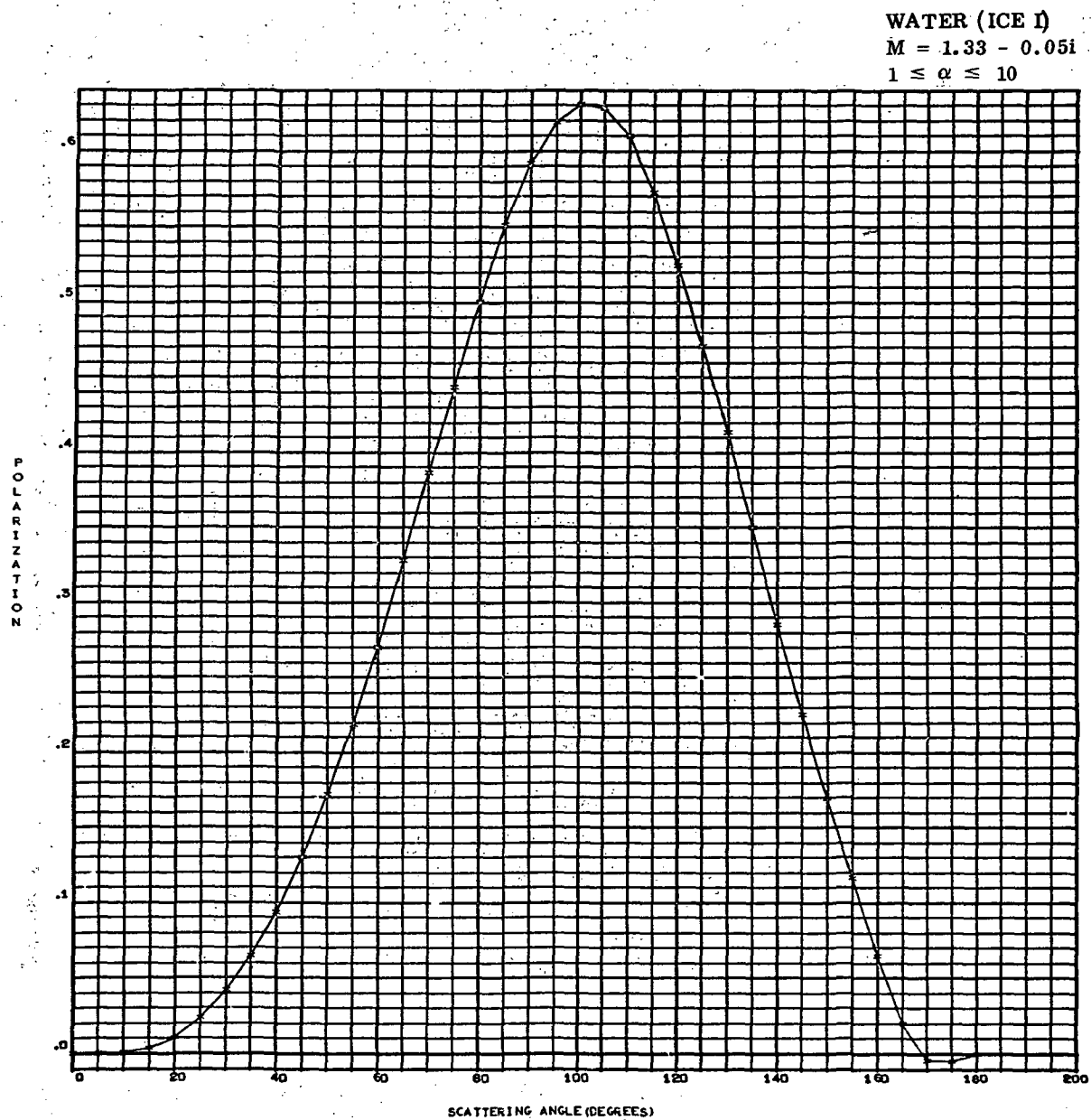


Figure 58. Polarization versus scattering angle  
for water (ice I) with  $1 \leq \alpha \leq 10$ .

WATER (ICE I)  
 $M = 1.33 - 0.05i$   
 $1 \leq \alpha \leq 5$

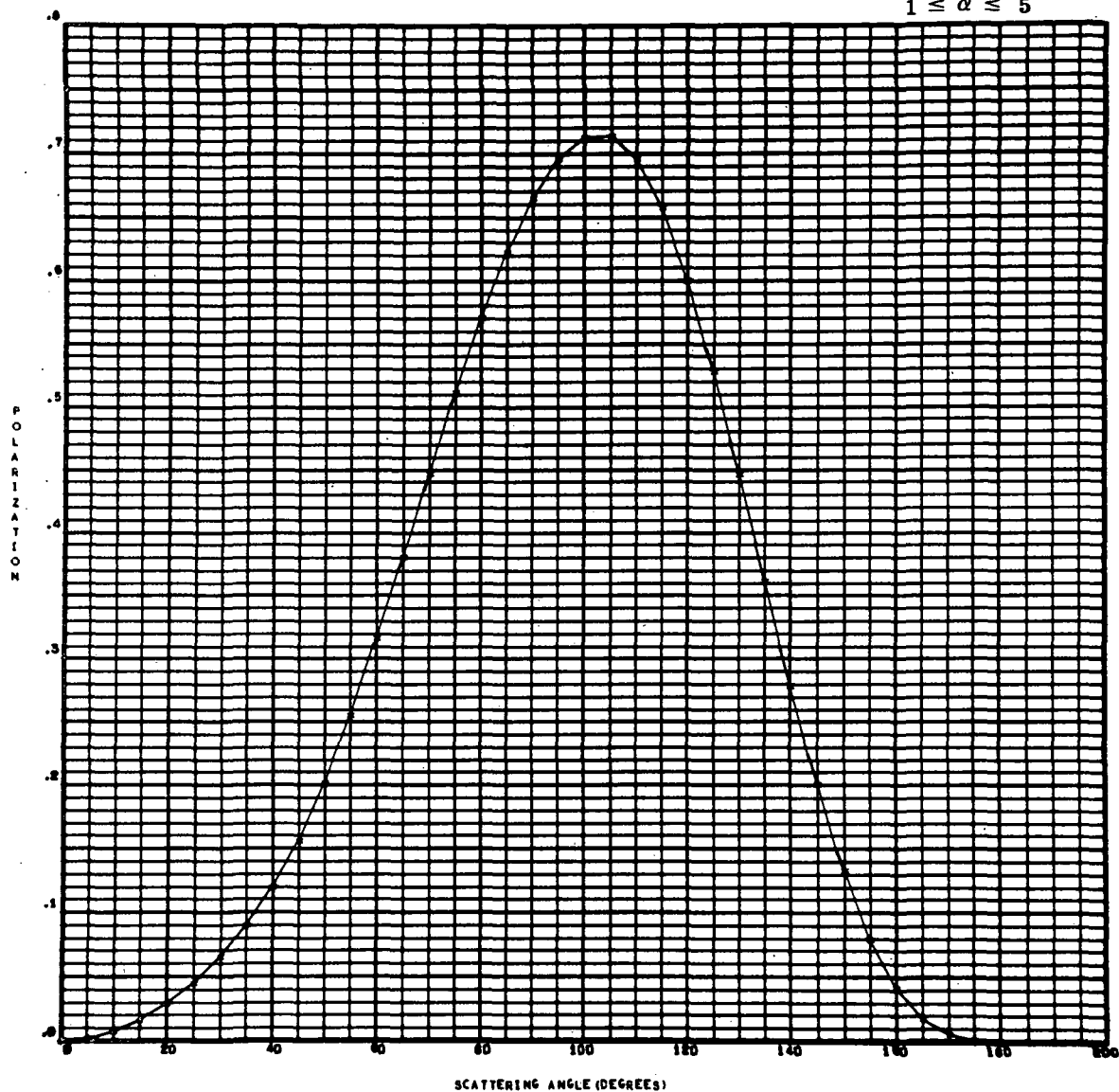


Figure 57. Polarization versus scattering angle  
for water (ice I) with  $1 \leq \alpha \leq 5$ .

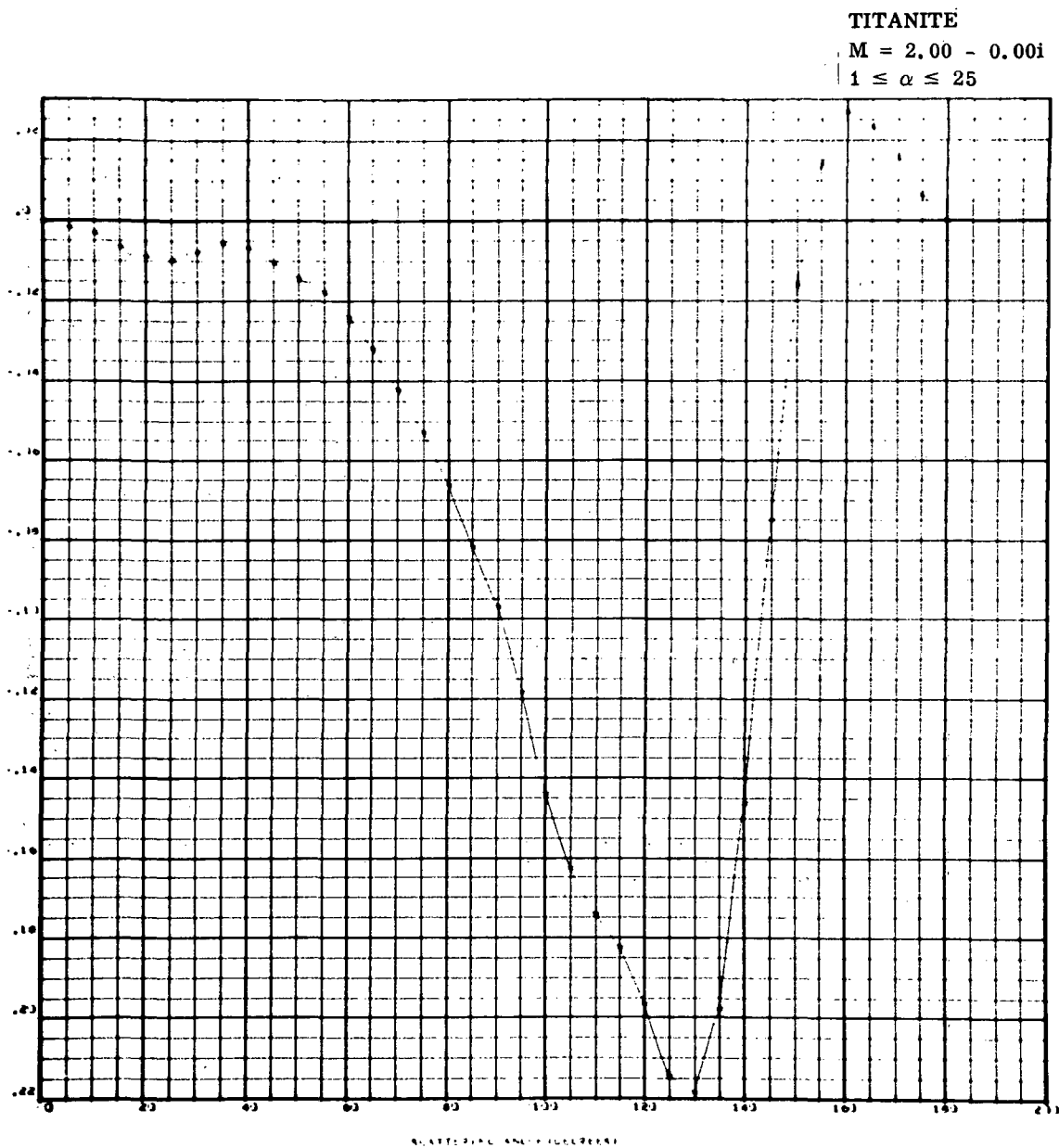


Figure 56. Polarization versus scattering angle  
for titanite with  $1 \leq \alpha \leq 25$ .

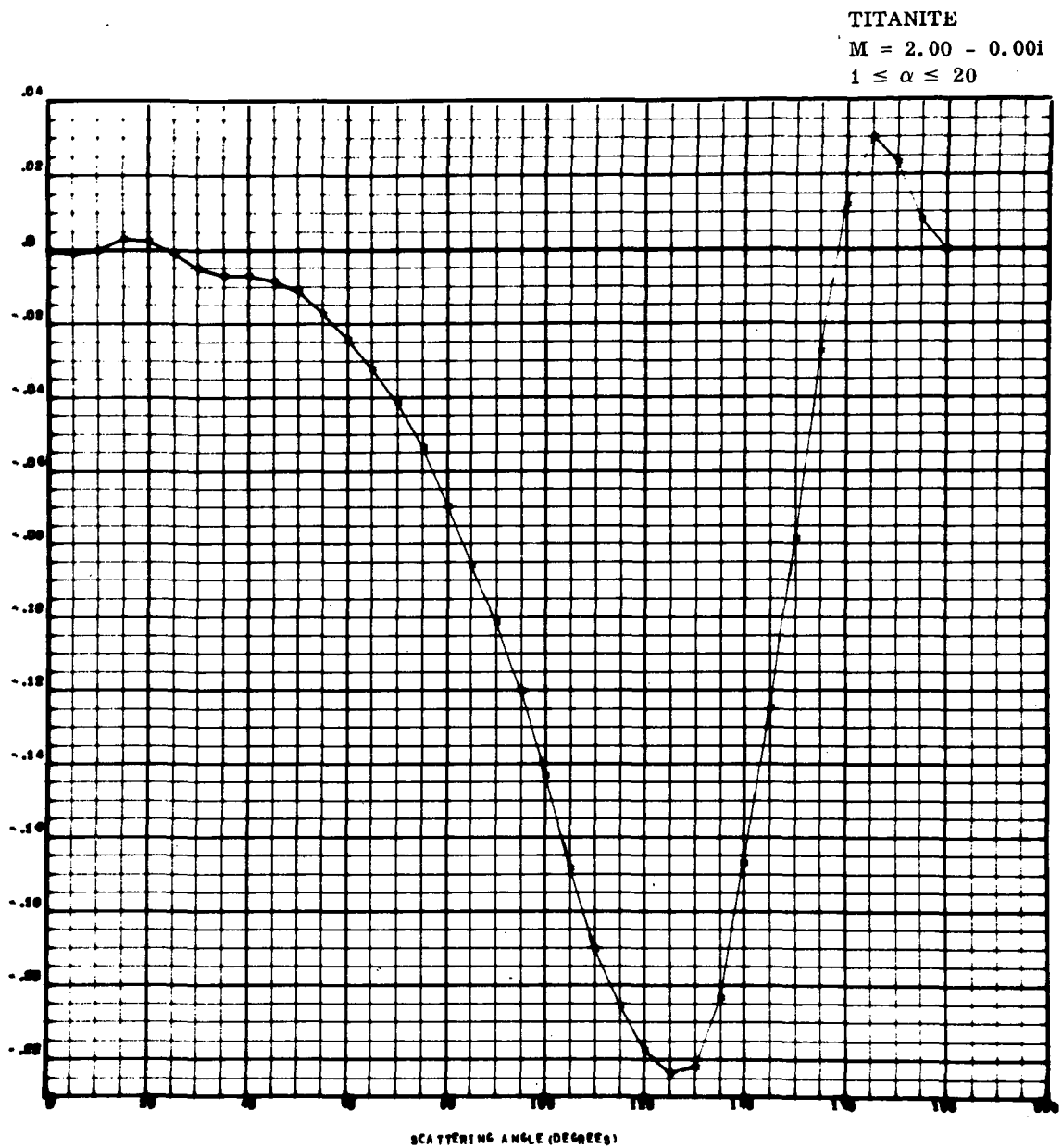


Figure 55. Polarization versus scattering angle  
for titanite with  $1 \leq \alpha \leq 20$ .

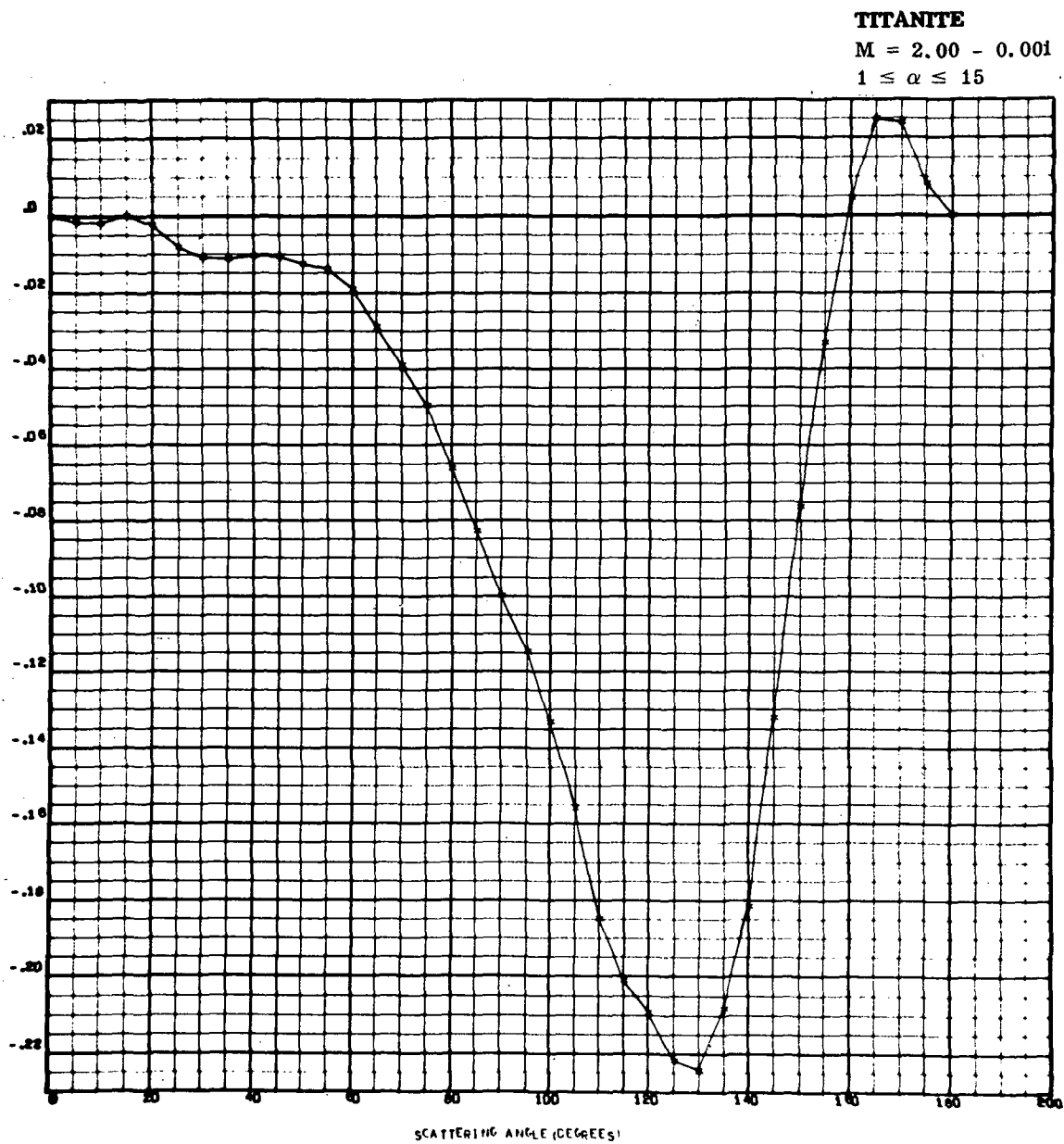


Figure 54. Polarization versus scattering angle  
for titanite with  $1 \leq \alpha \leq 15$ .

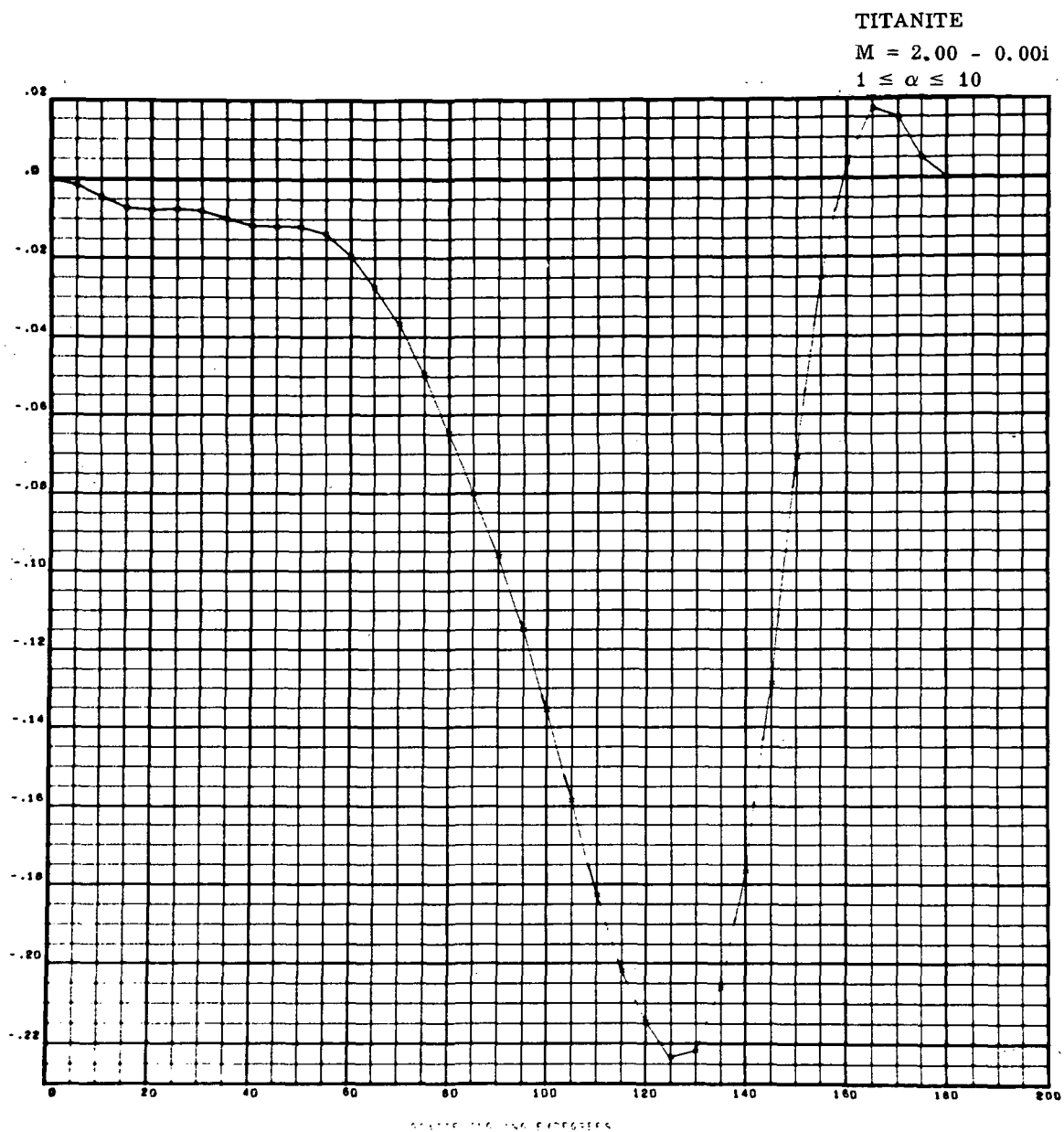


Figure 53. Polarization versus scattering angle  
for titanite with  $1 \leq \alpha \leq 10$ .

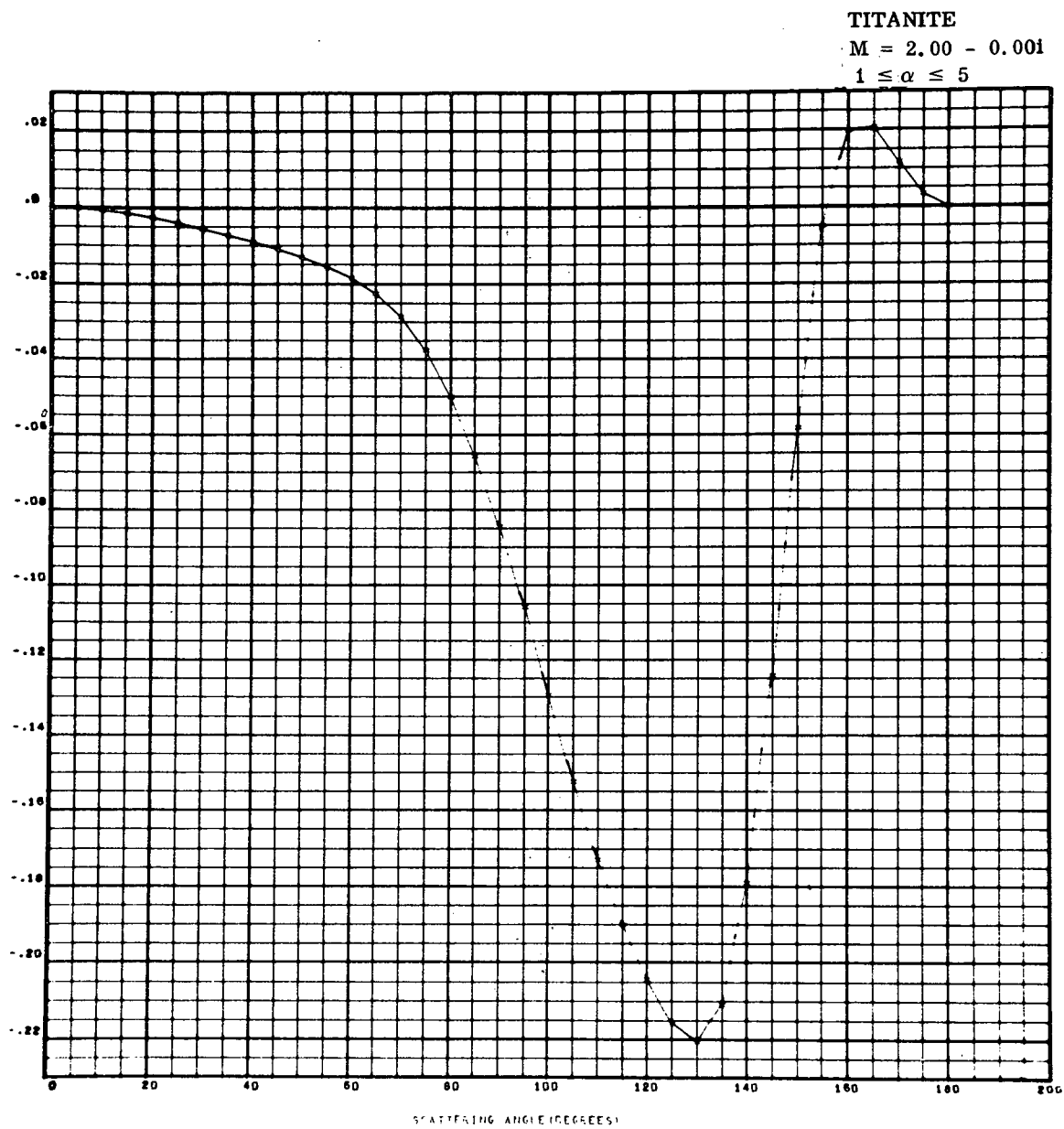


Figure 52. Polarization versus scattering angle  
for titanite with  $1 \leq \alpha \leq 5$ .

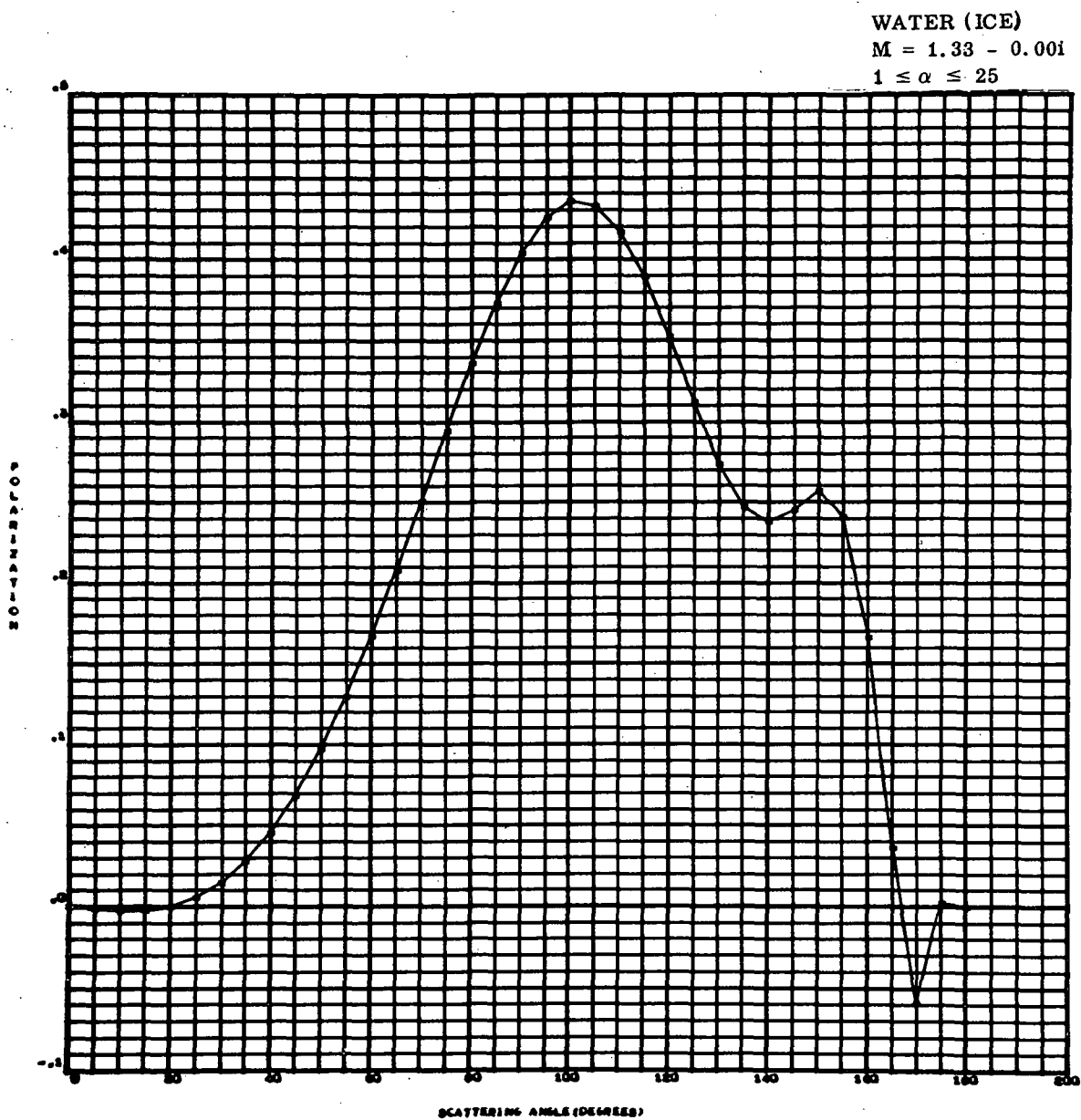


Figure 51. Polarization versus scattering angle  
for water (ice) with  $1 \leq \alpha \leq 25$ .



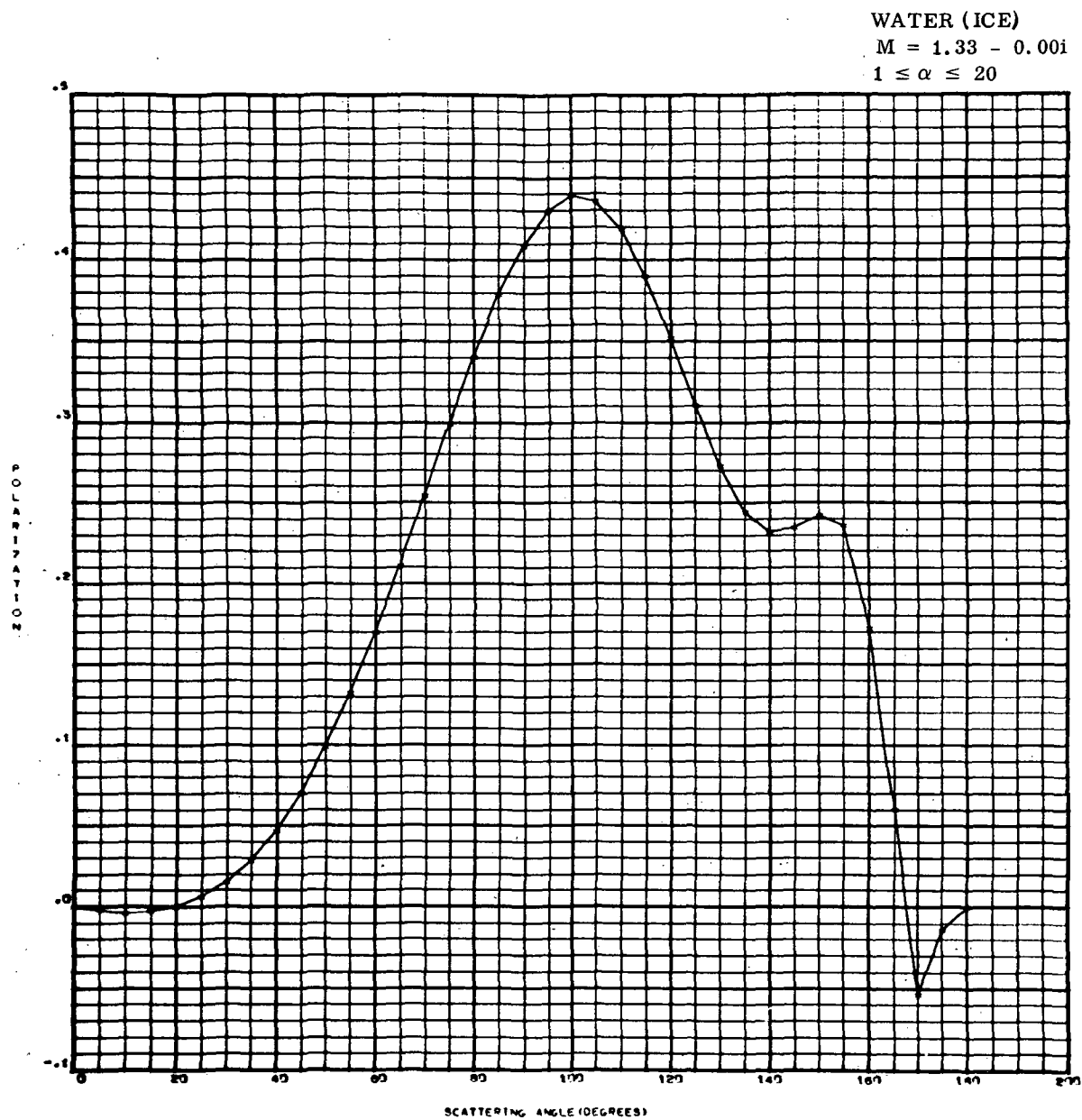


Figure 50. Polarization versus scattering angle  
for water (ice) with  $1 \leq \alpha \leq 20$ .

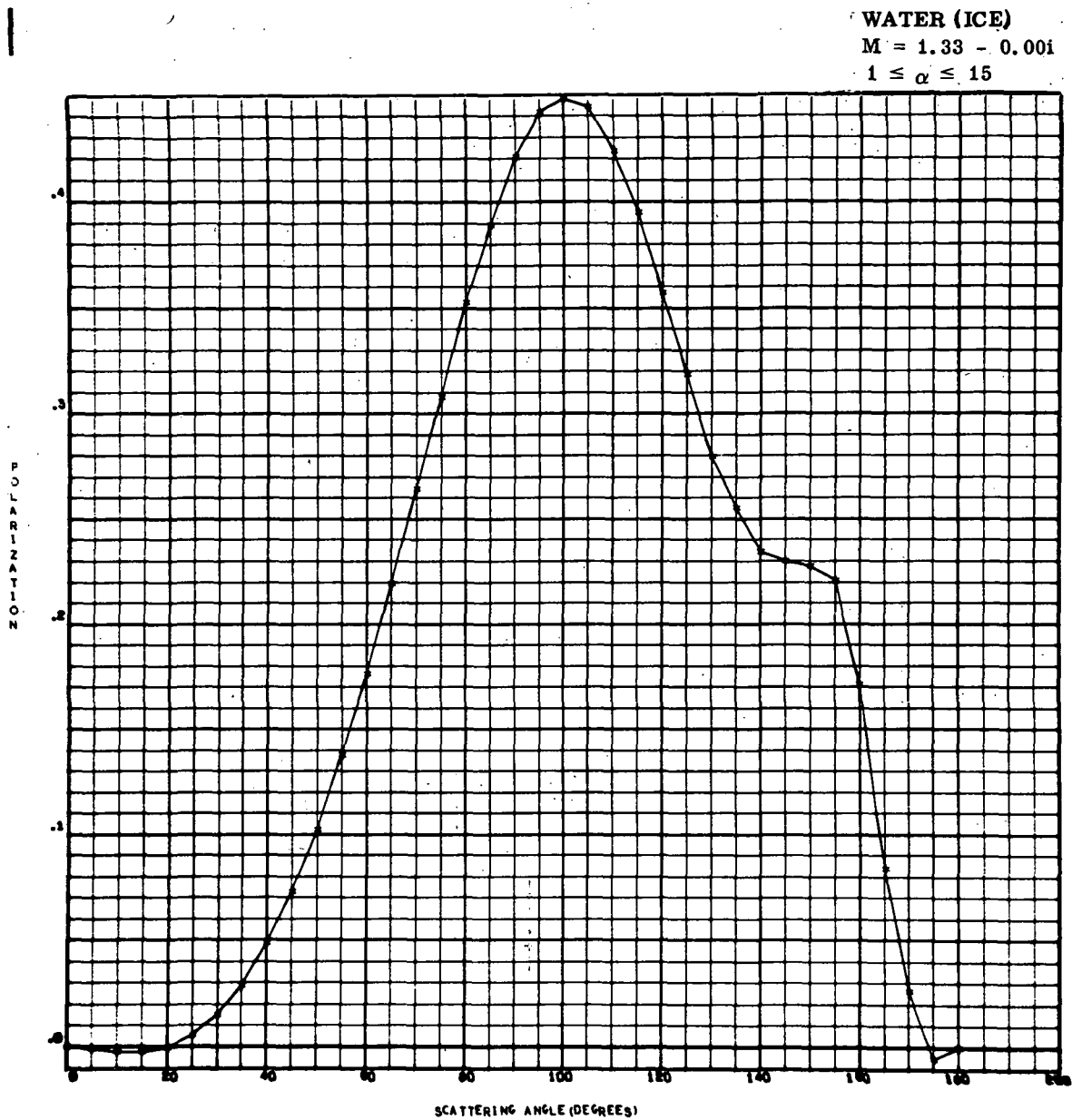


Figure 49. Polarization versus scattering angle  
for water (ice) with  $1 \leq \alpha \leq 15$ .

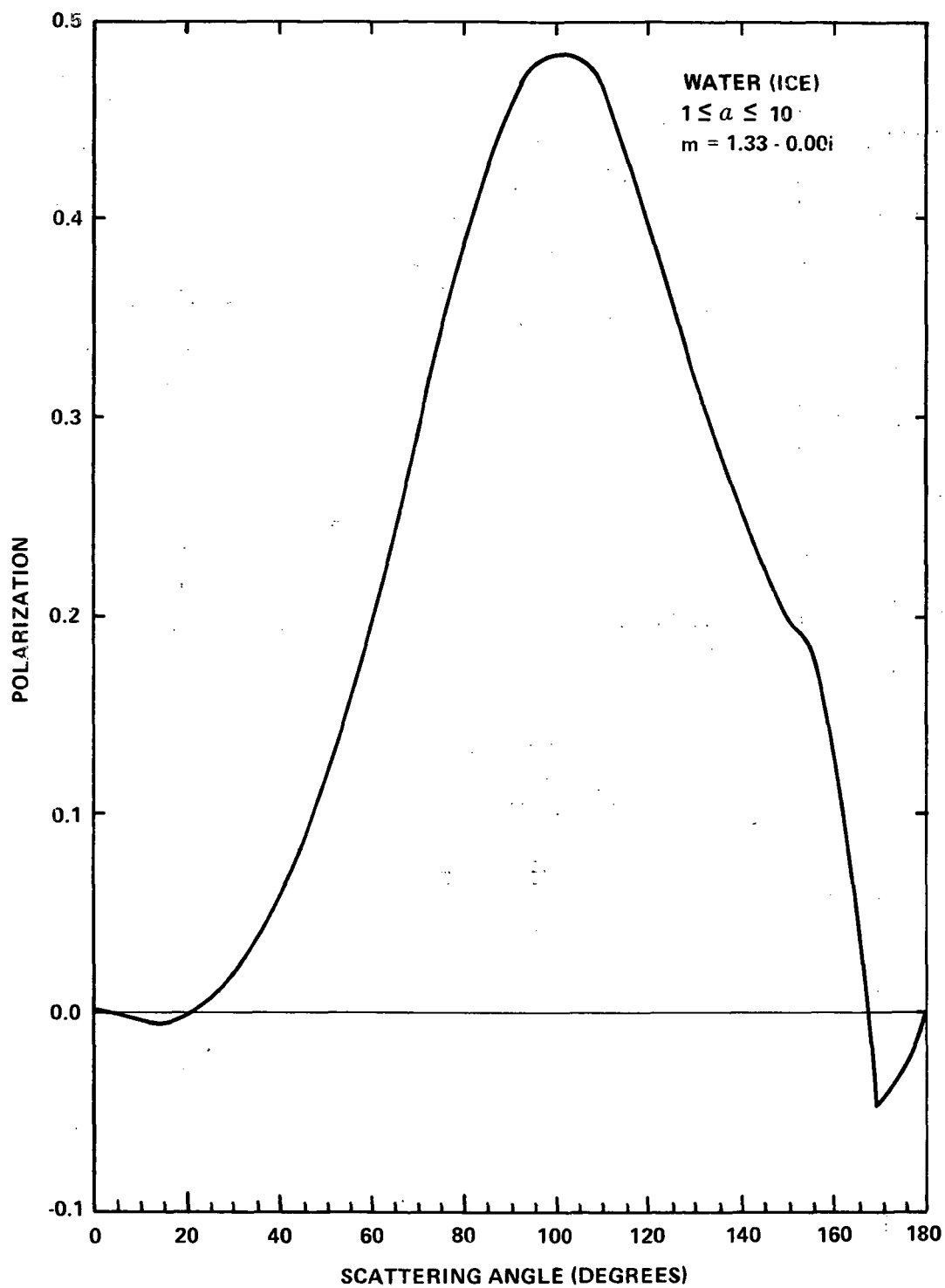


Figure 48. Polarization versus scattering angle  
for water (ice) with  $1 \leq \alpha \leq 10$ .

WATER (ICE)  
 $M = 1.33 - 0.00i$   
 $1 \leq \alpha \leq 5$

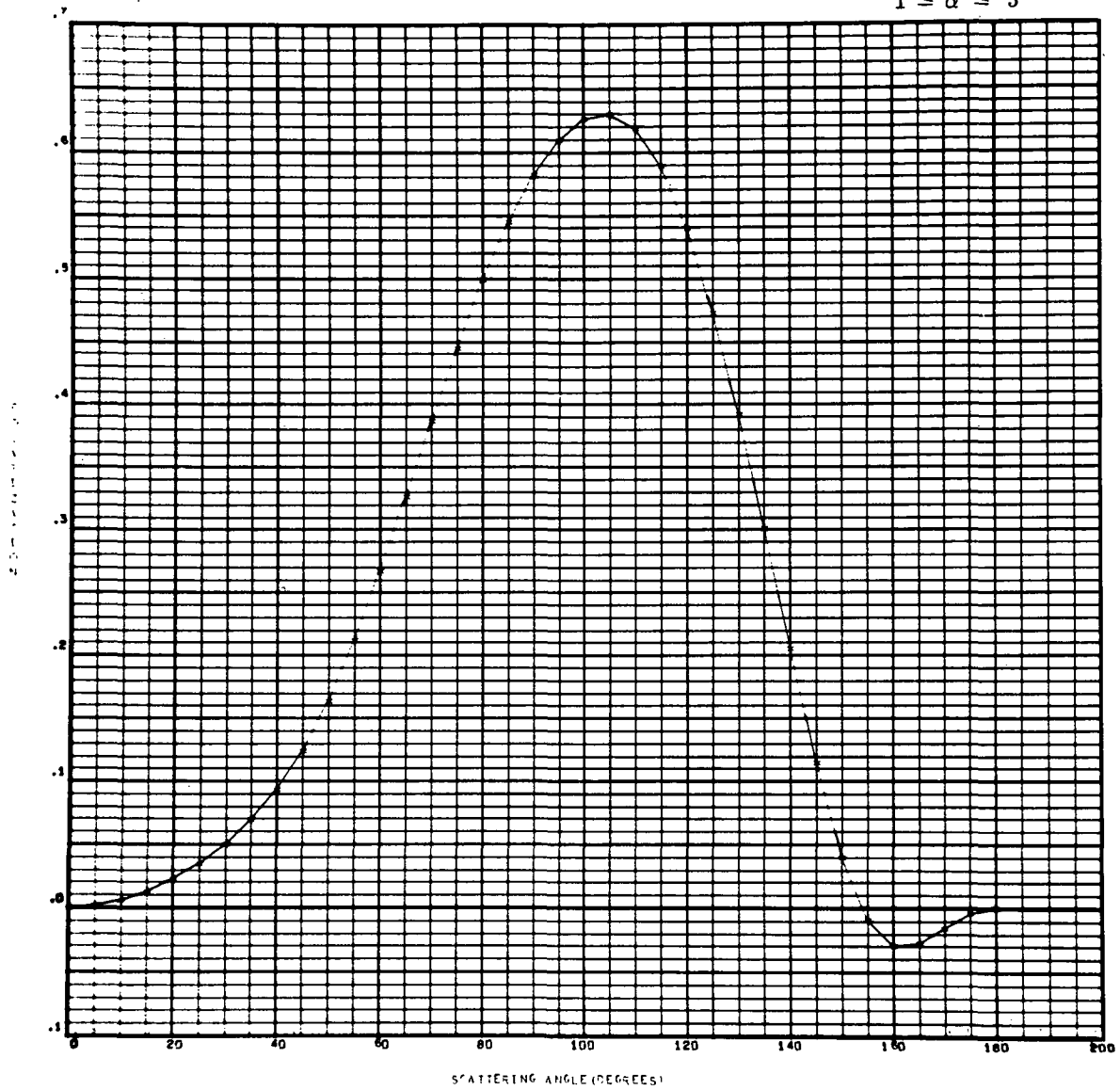


Figure 47. Polarization versus scattering angle  
for water (ice) with  $1 \leq \alpha \leq 5$ .

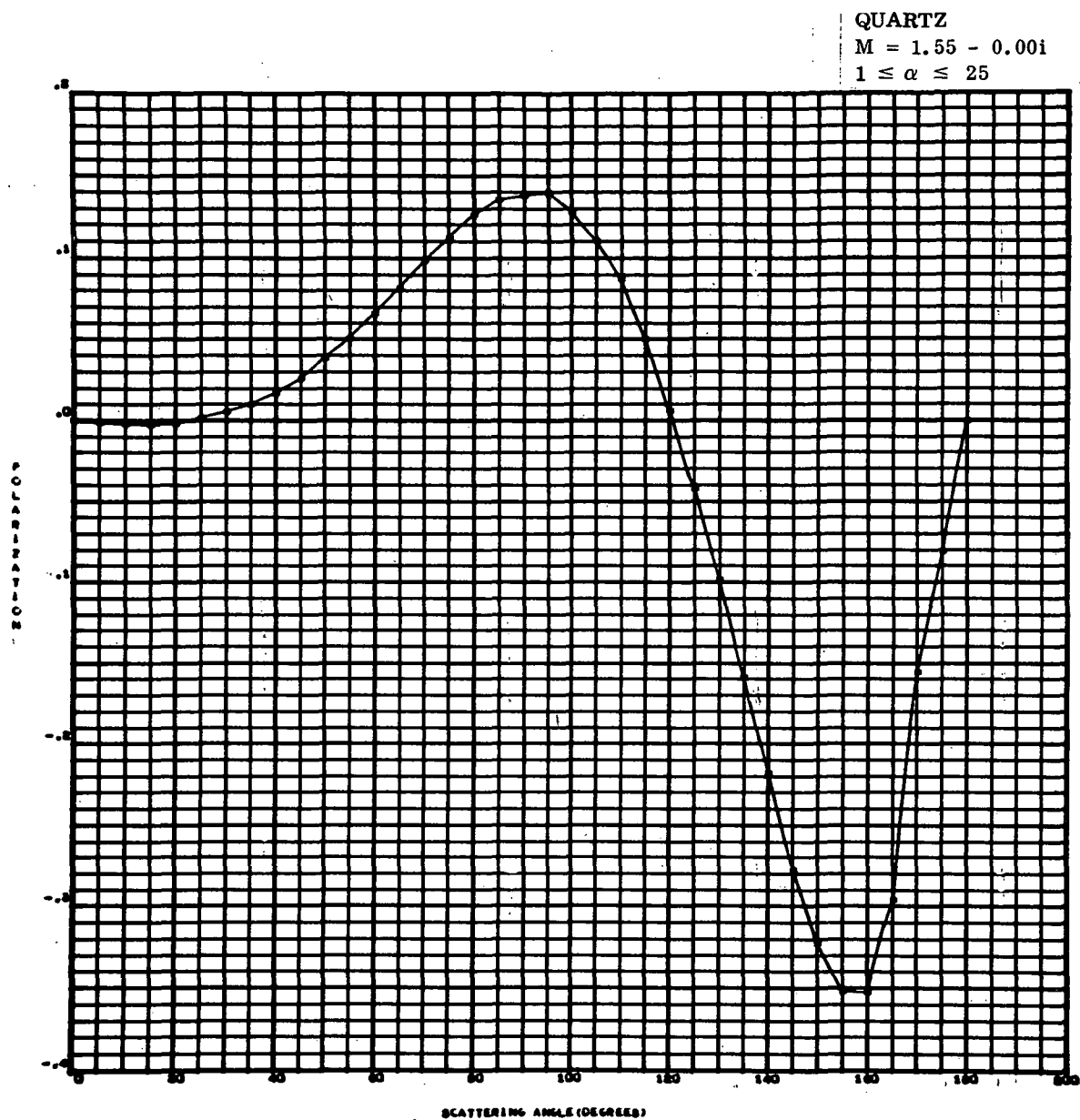


Figure 46. Polarization versus scattering angle  
for quartz with  $1 \leq \alpha \leq 25$ .

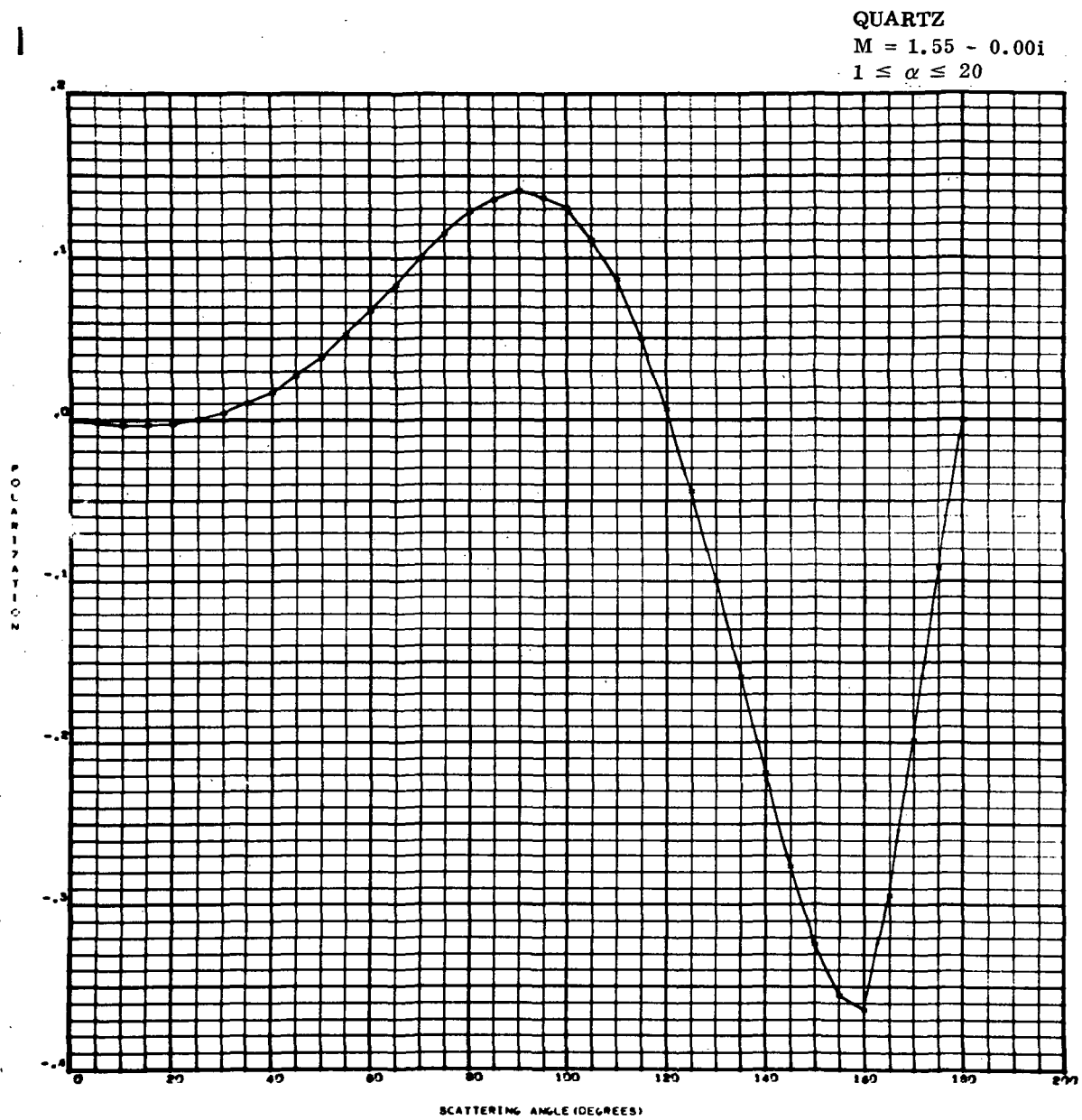


Figure 45. Polarization versus scattering angle  
for quartz with  $1 \leq \alpha \leq 20$ .

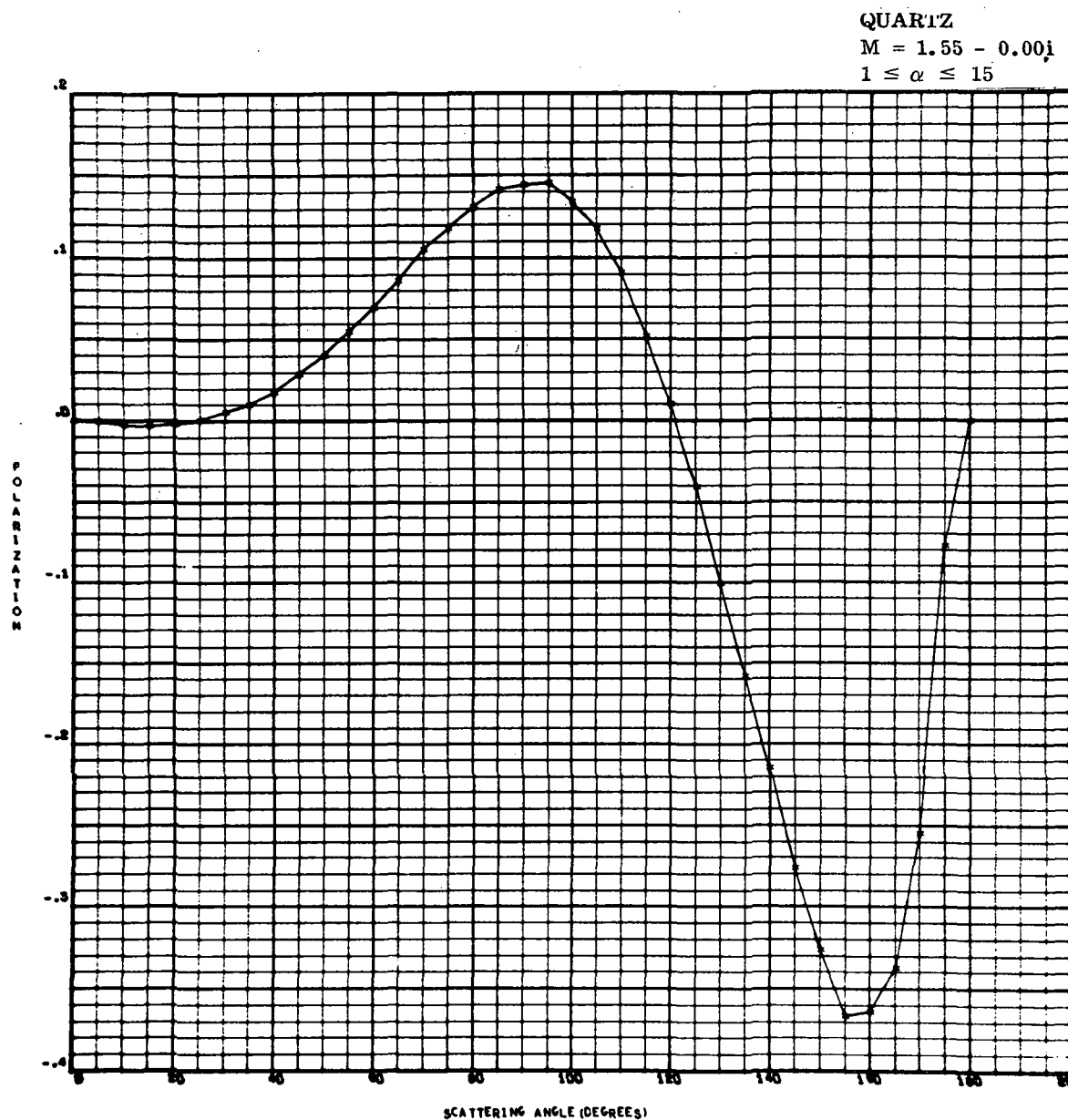


Figure 44. Polarization versus scattering angle  
for quartz with  $1 \leq \alpha \leq 15$ .

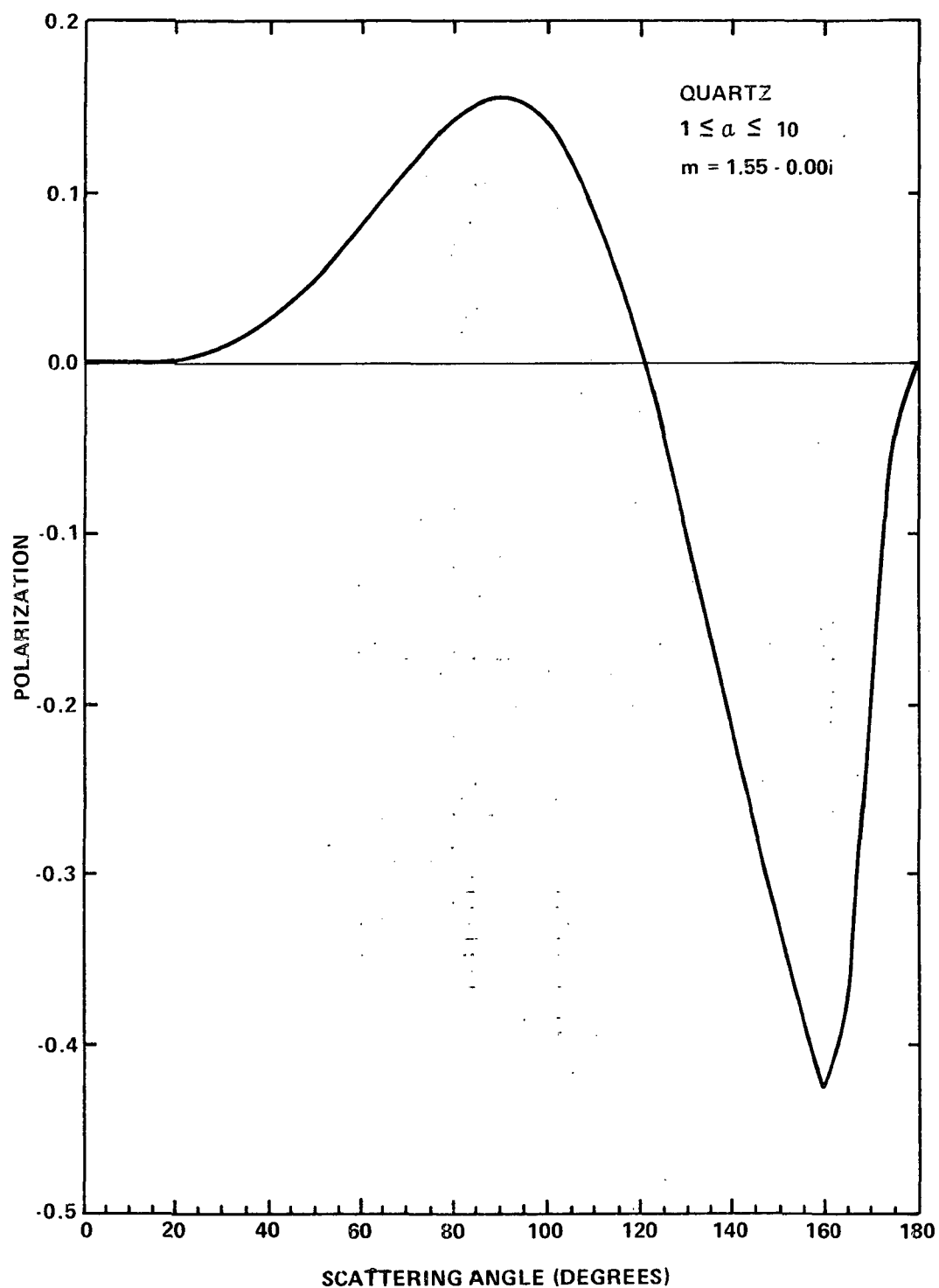


Figure 43. Polarization versus scattering angle  
for quartz with  $1 \leq \alpha \leq 10$ .



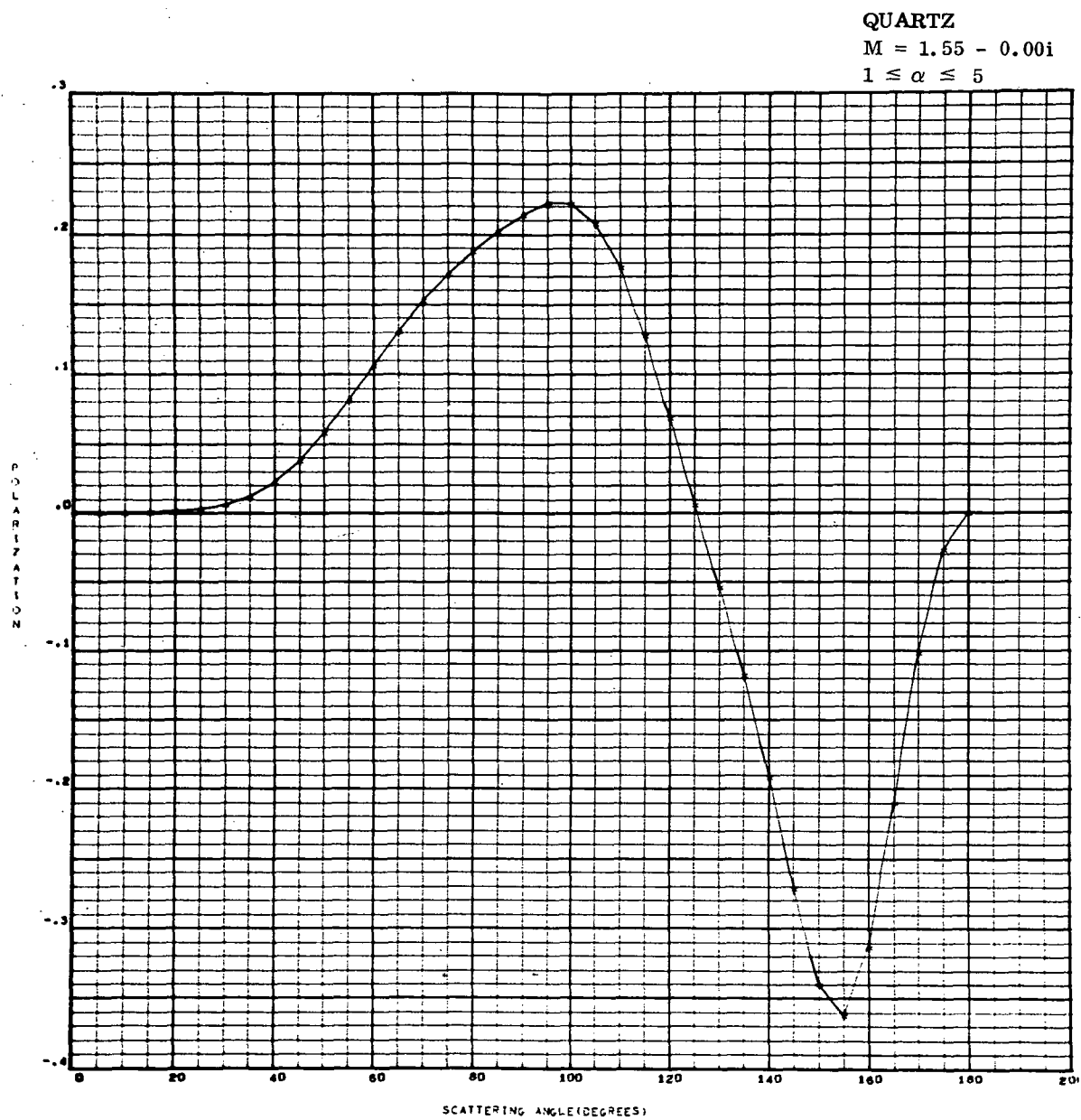


Figure 42. Polarization versus scattering angle  
for quartz with  $1 \leq \alpha \leq 5$ .

ZINC  
 $M = 1.41 - 4.10i$   
 $1 \leq \alpha \leq 25$

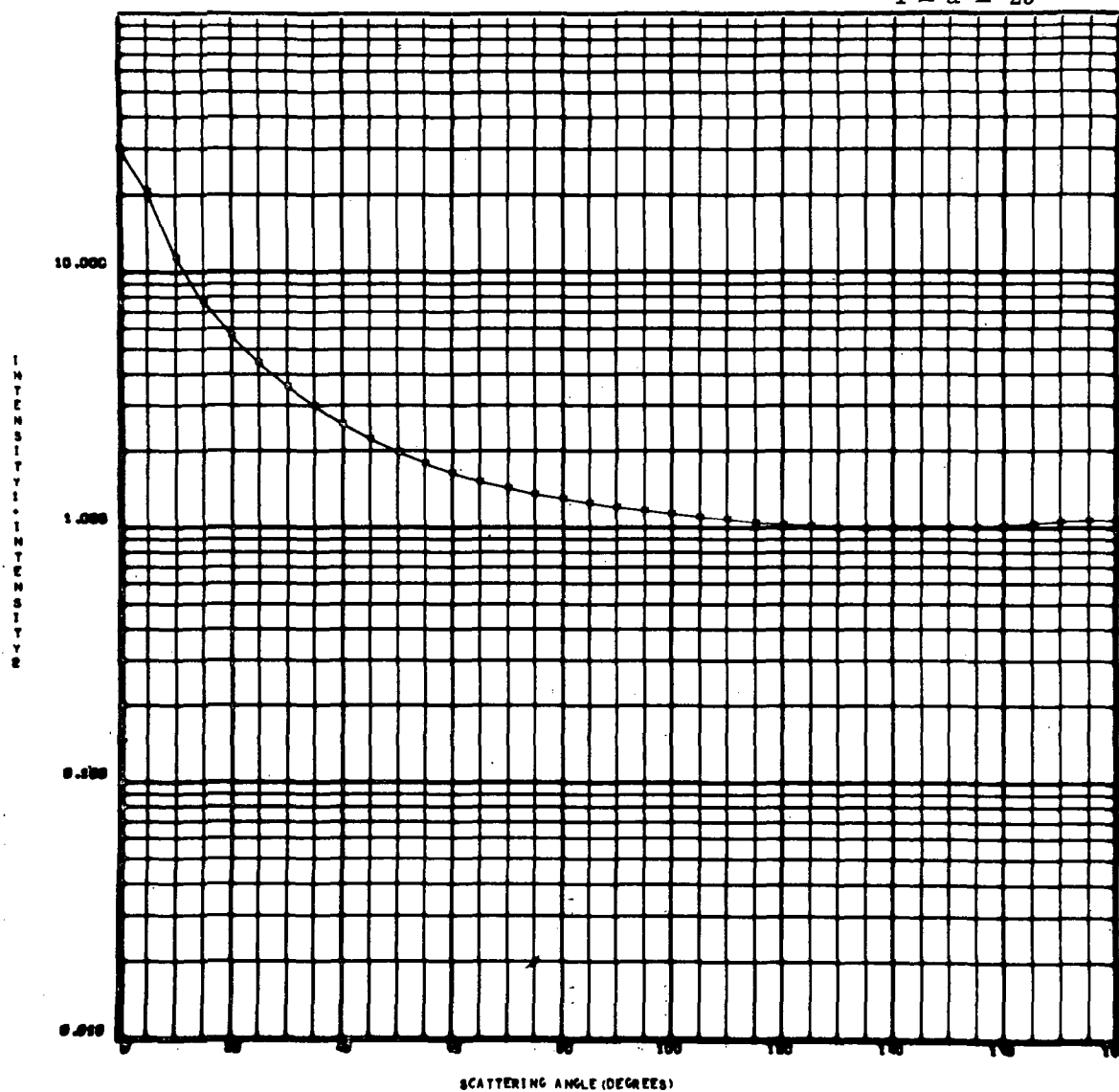


Figure 41. Intensity versus scattering angle  
for zinc with  $1 \leq \alpha \leq 25$ .

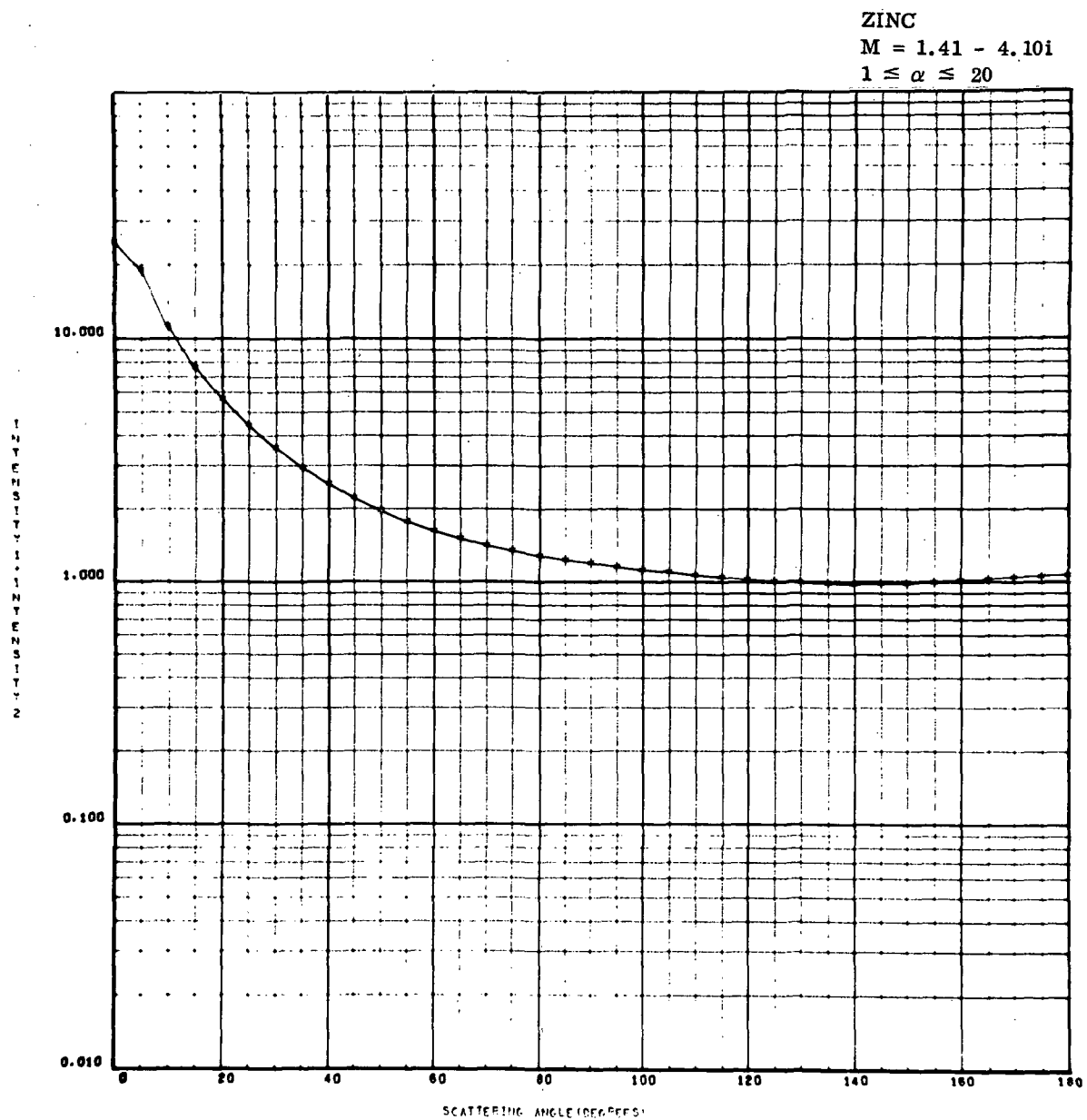


Figure 40. Intensity versus scattering angle  
for zinc with  $1 \leq \alpha \leq 20$ .

ZINC  
 $M = 1.41 - 4.10i$   
 $1 \leq \alpha \leq 15$

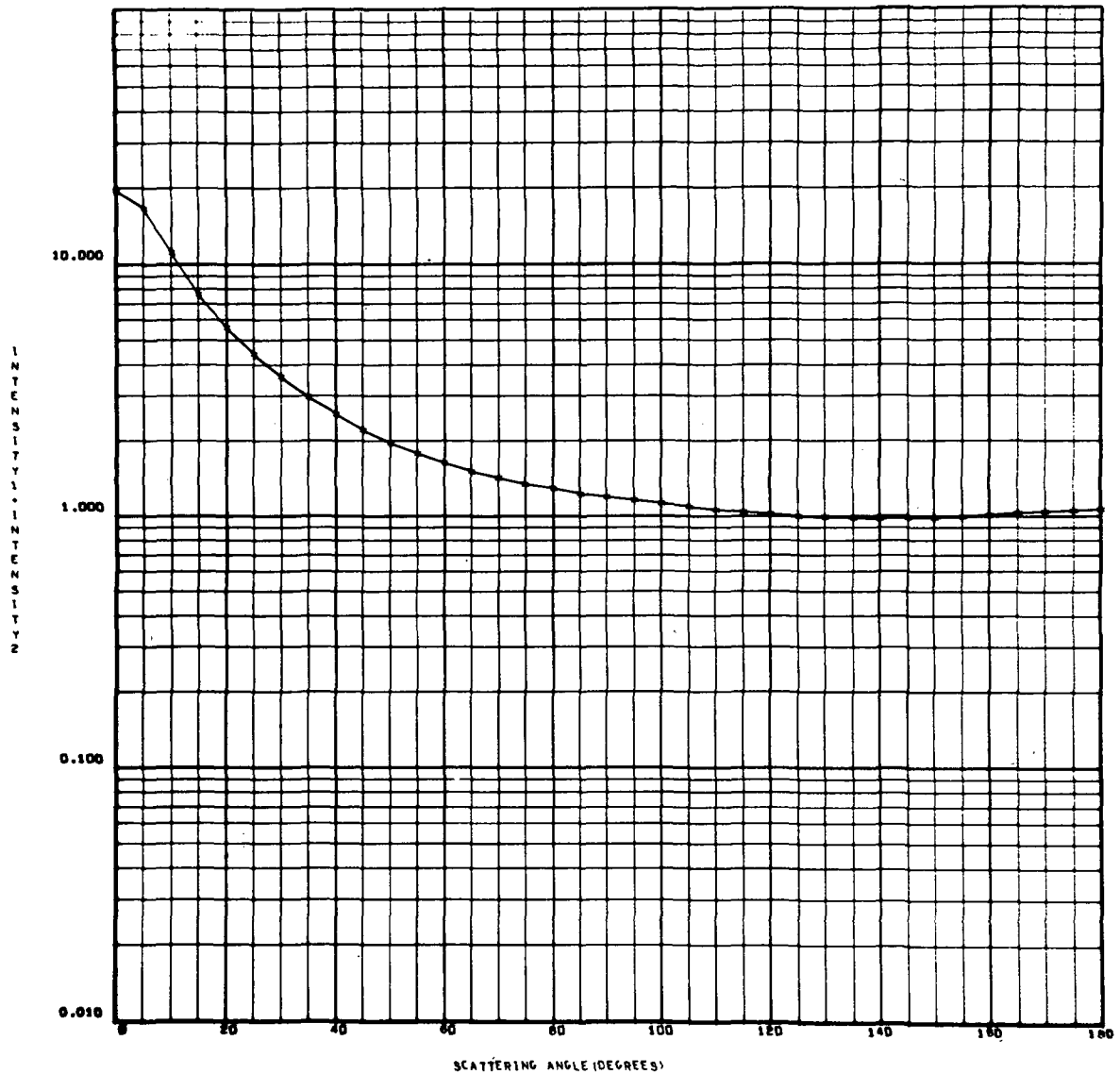


Figure 39. Intensity versus scattering angle  
for zinc with  $1 \leq \alpha \leq 15$ .

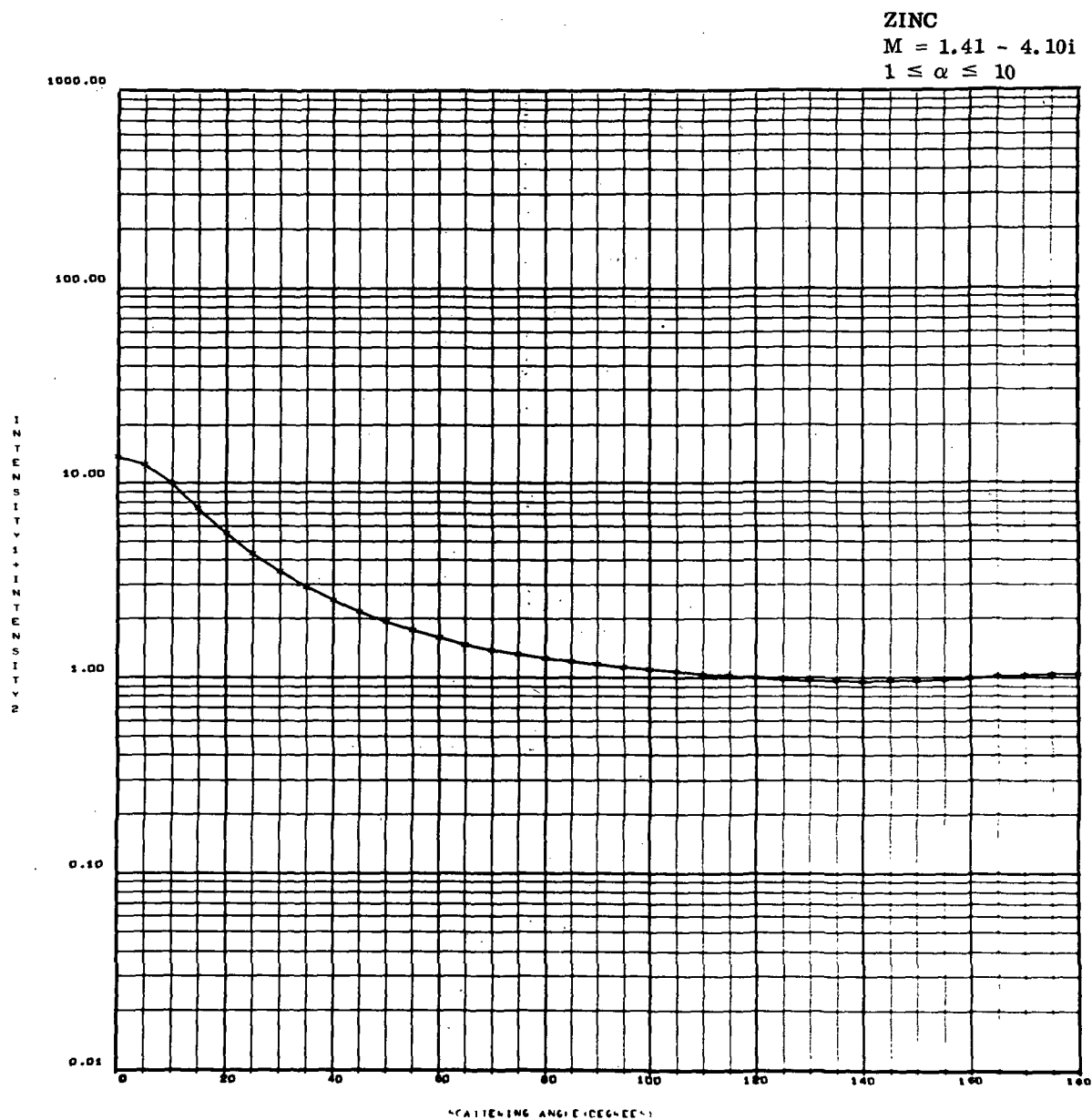


Figure 38. Intensity versus scattering angle  
for zinc with  $1 \leq \alpha \leq 10$ .

ZINC  
 $M = 1.41 - 4.10i$   
 $1 \leq \alpha \leq 5$

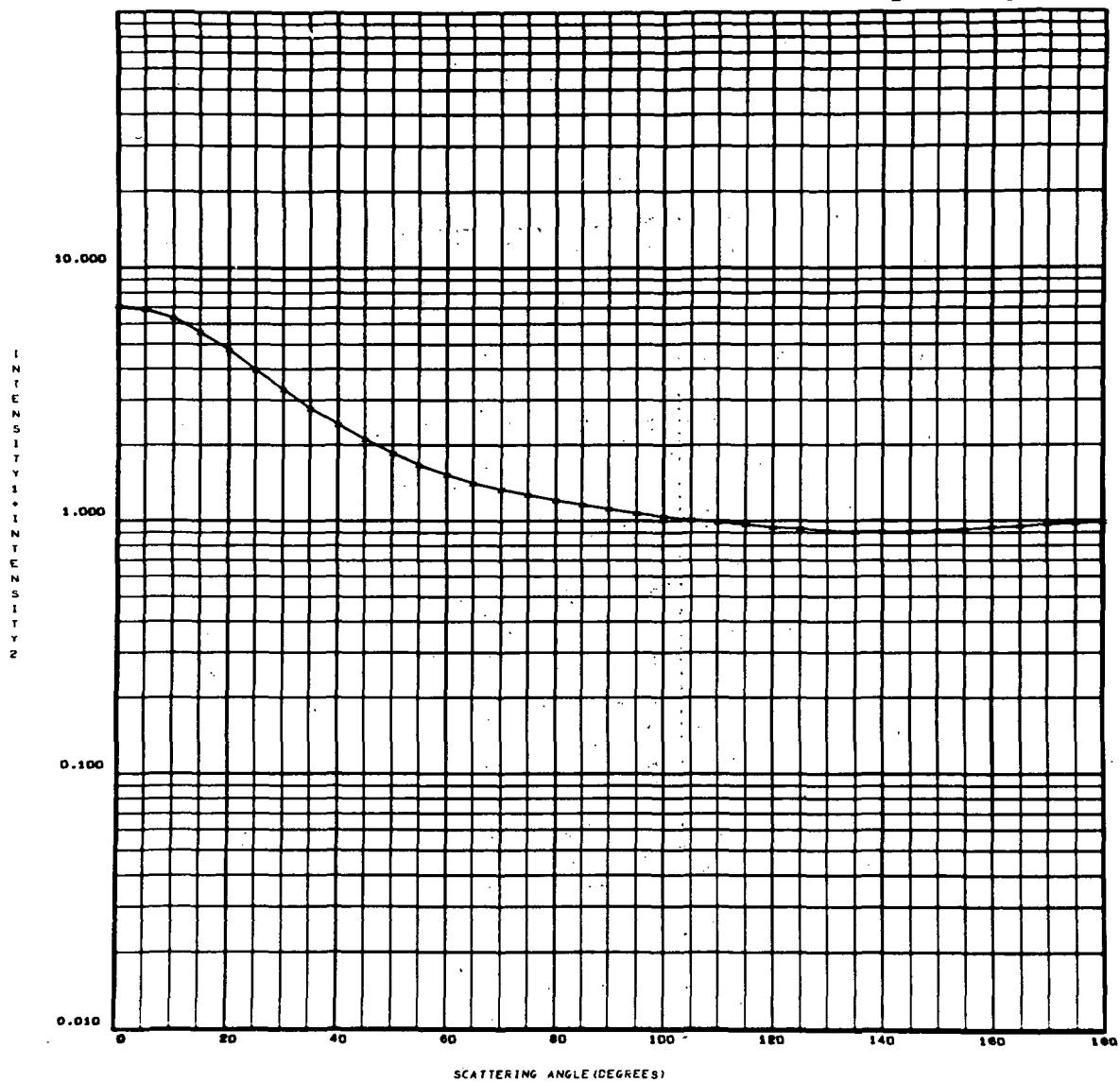


Figure 37. Intensity versus scattering angle  
for zinc with  $1 \leq \alpha \leq 5$ .

IRON  
 $M = 1.27 - 1.37i$   
 $1 \leq \alpha \leq 25$

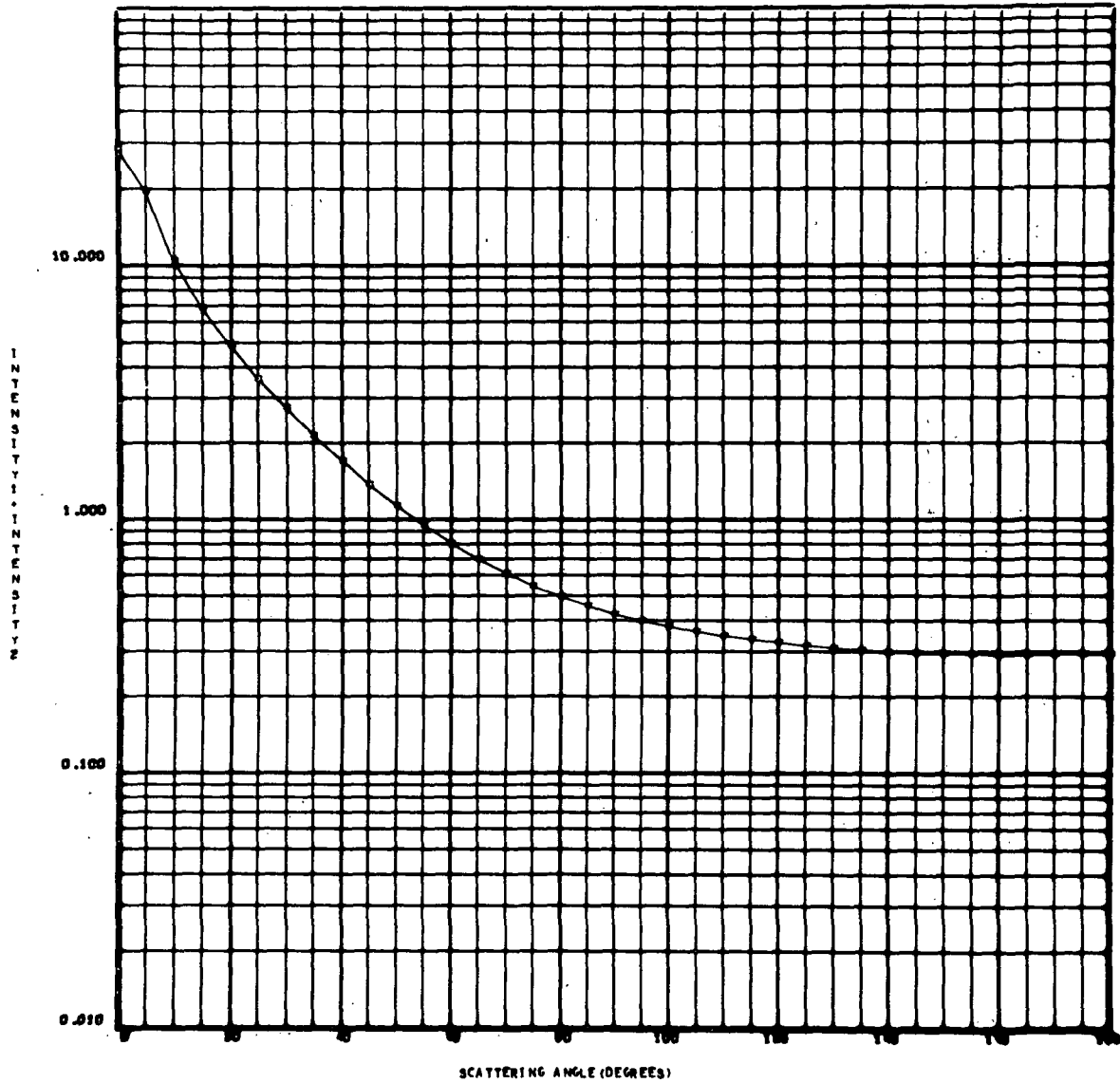


Figure 36. Intensity versus scattering angle  
for iron with  $1 \leq \alpha \leq 25$ .

IRON

$M = 1.27 - 1.371$

$1 \leq \alpha \leq 20$

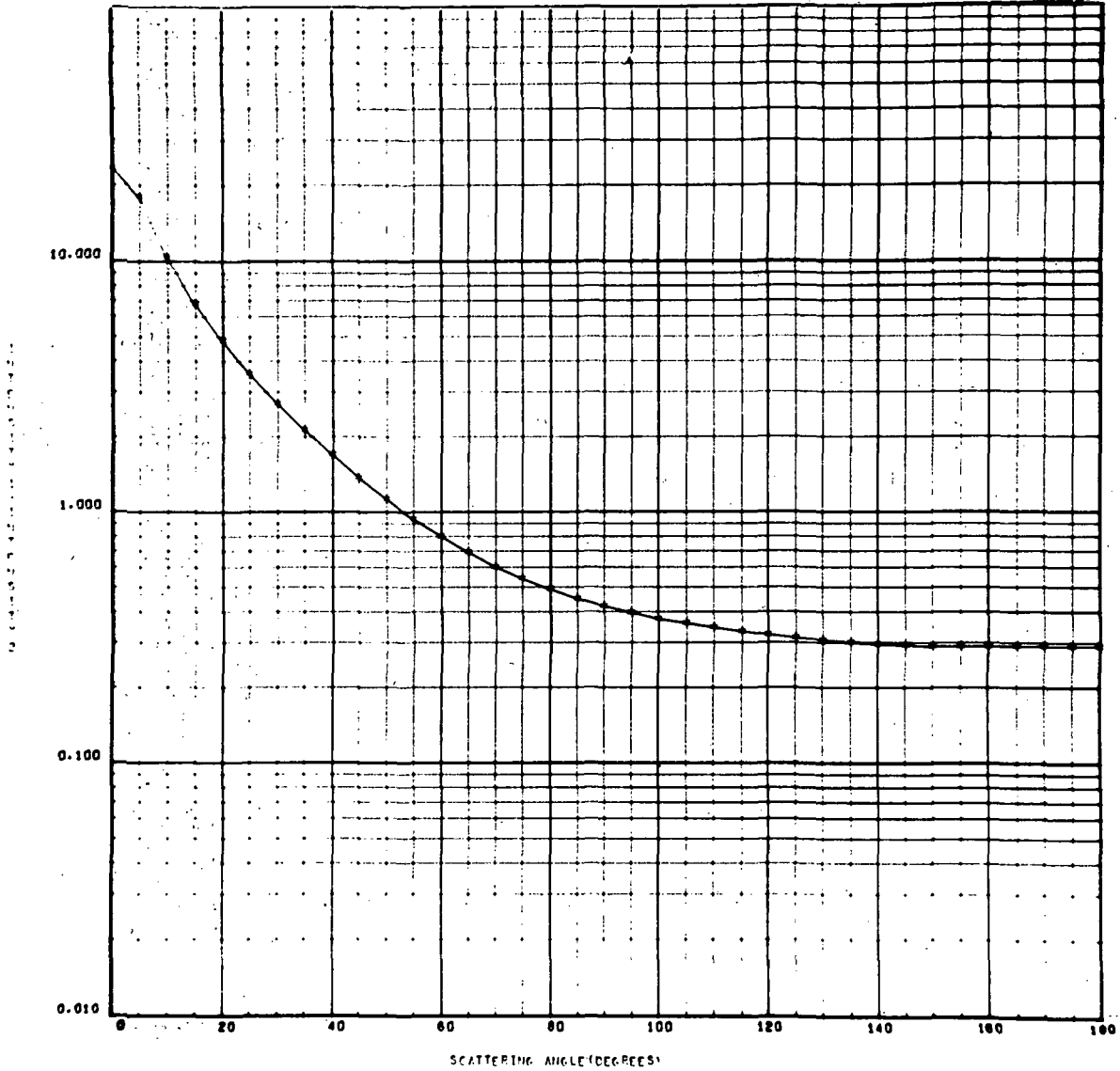


Figure 35. Intensity versus scattering angle  
for iron with  $1 \leq \alpha \leq 20$ .



IRON

$$M = 1.27 - 1.37i$$

$$1 \leq \alpha \leq 15$$

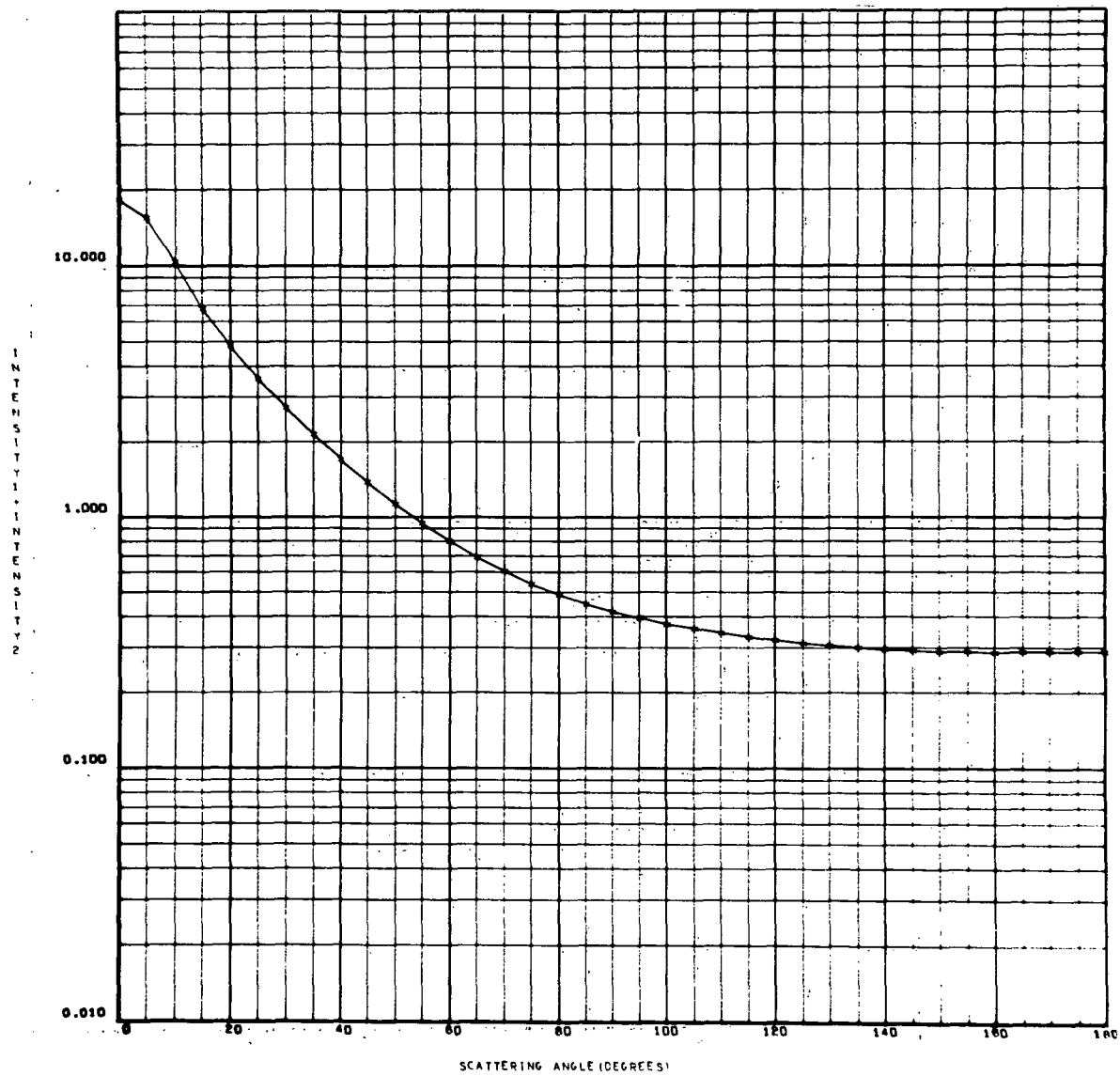


Figure 34. Intensity versus scattering angle  
for iron with  $1 \leq \alpha \leq 15$ .

IRON  
 $M = 1.27 - 1.37i$   
 $1 \leq \alpha \leq 10$

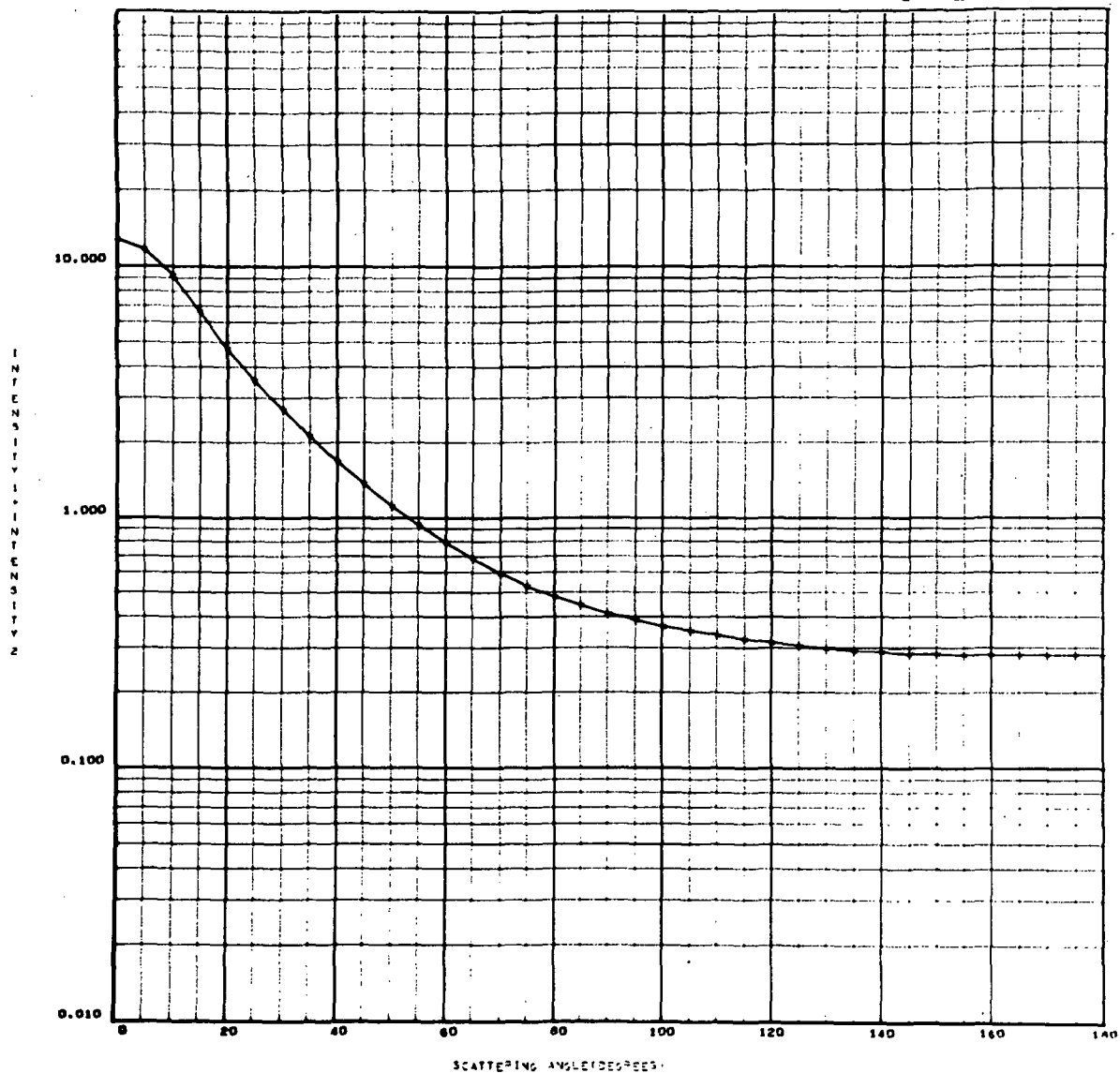


Figure 33. Intensity versus scattering angle  
for iron with  $1 \leq \alpha \leq 10$ .

IRON  
 $M = 1.27 - 1.37i$   
 $1 \leq \alpha \leq 5$

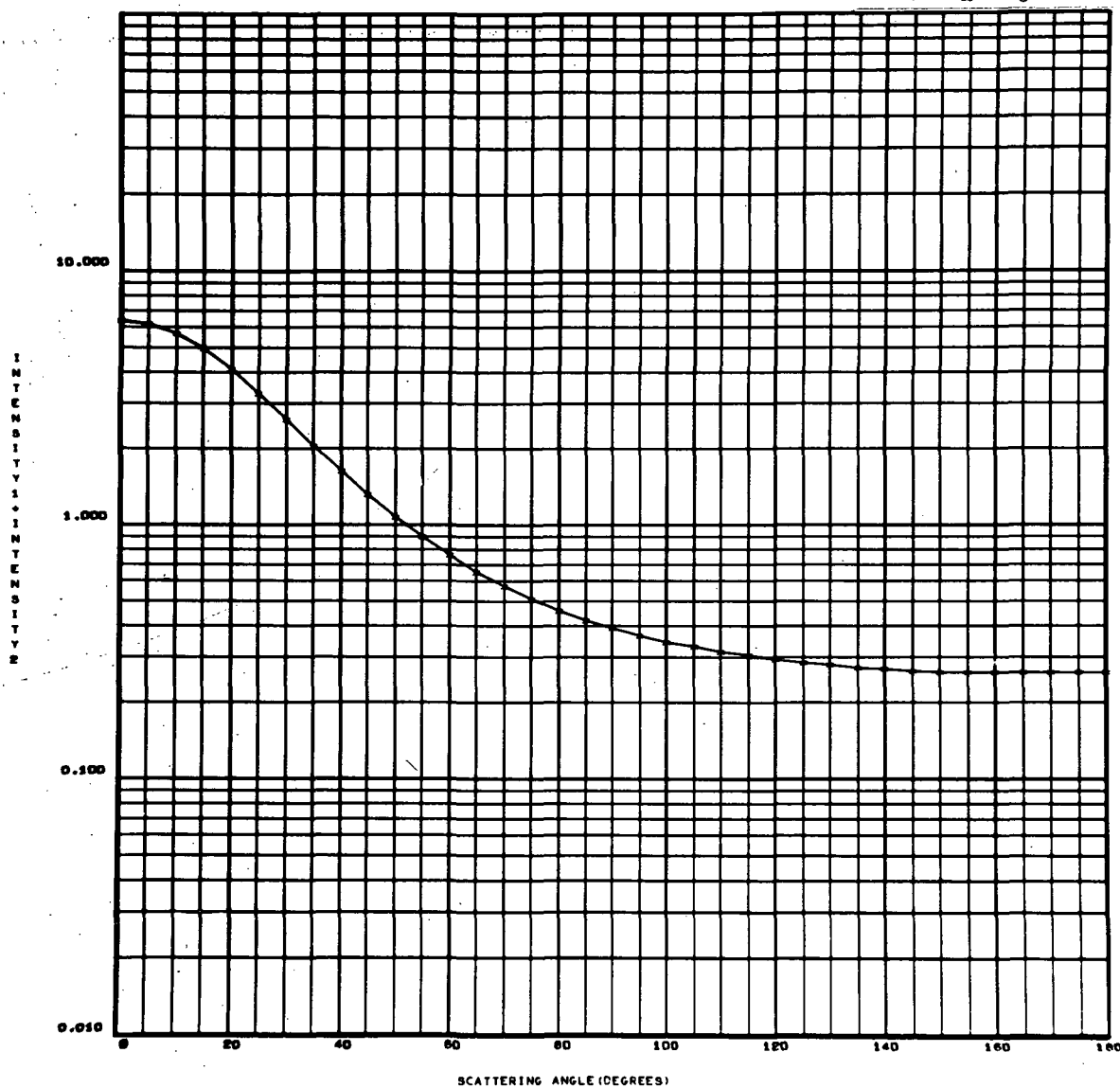


Figure 32. Intensity versus scattering angle  
for iron with  $1 \leq \alpha \leq 5$ .

GRAPHITE  
 $M = 1.59 - 0.66i$   
 $1 \leq \alpha \leq 25$

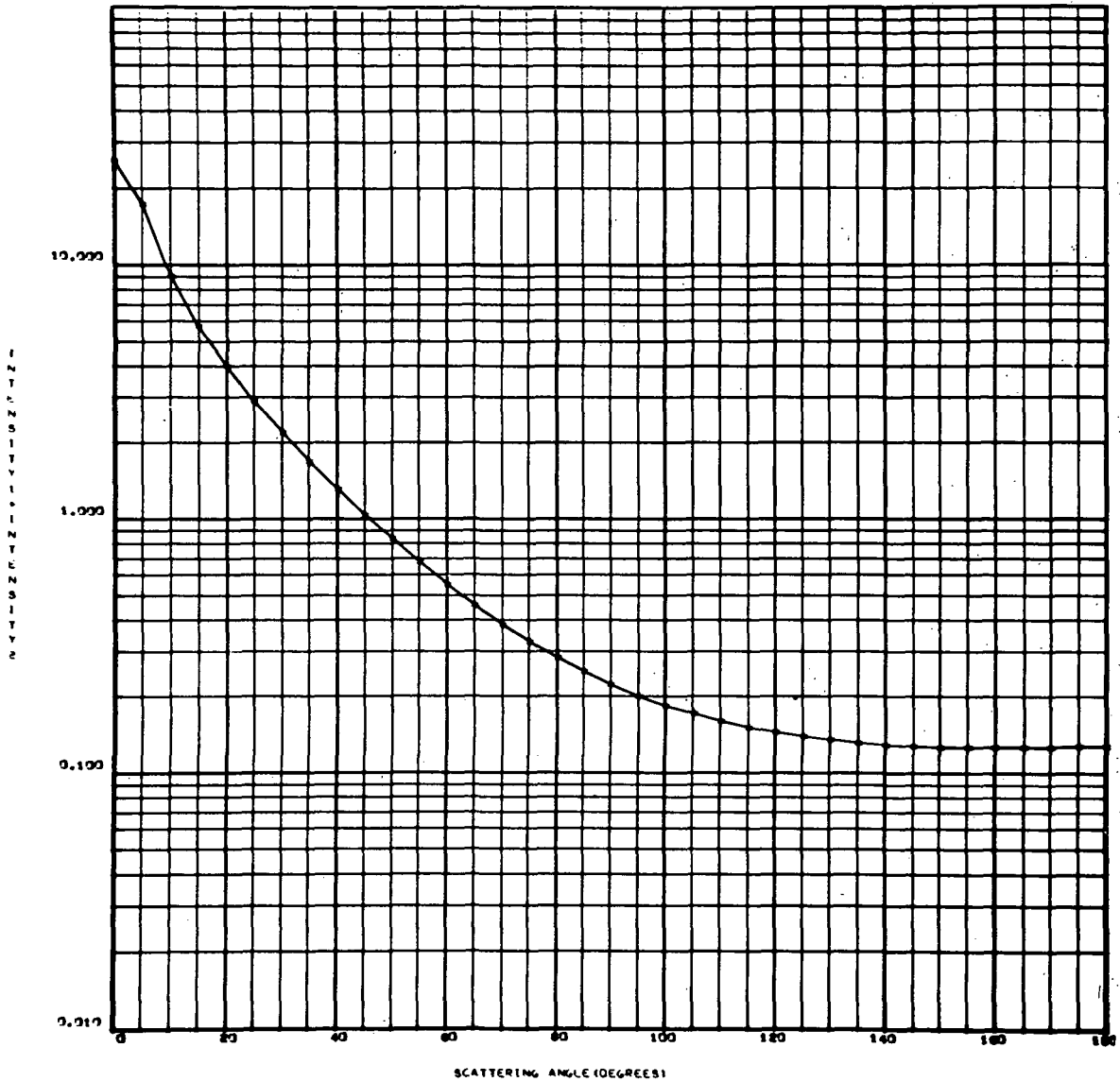


Figure 31. Intensity versus scattering angle  
for graphite with  $1 \leq \alpha \leq 25$ .

GRAPHITE  
 $M = 1.59 - 0.66i$   
 $1 \leq \alpha \leq 20$

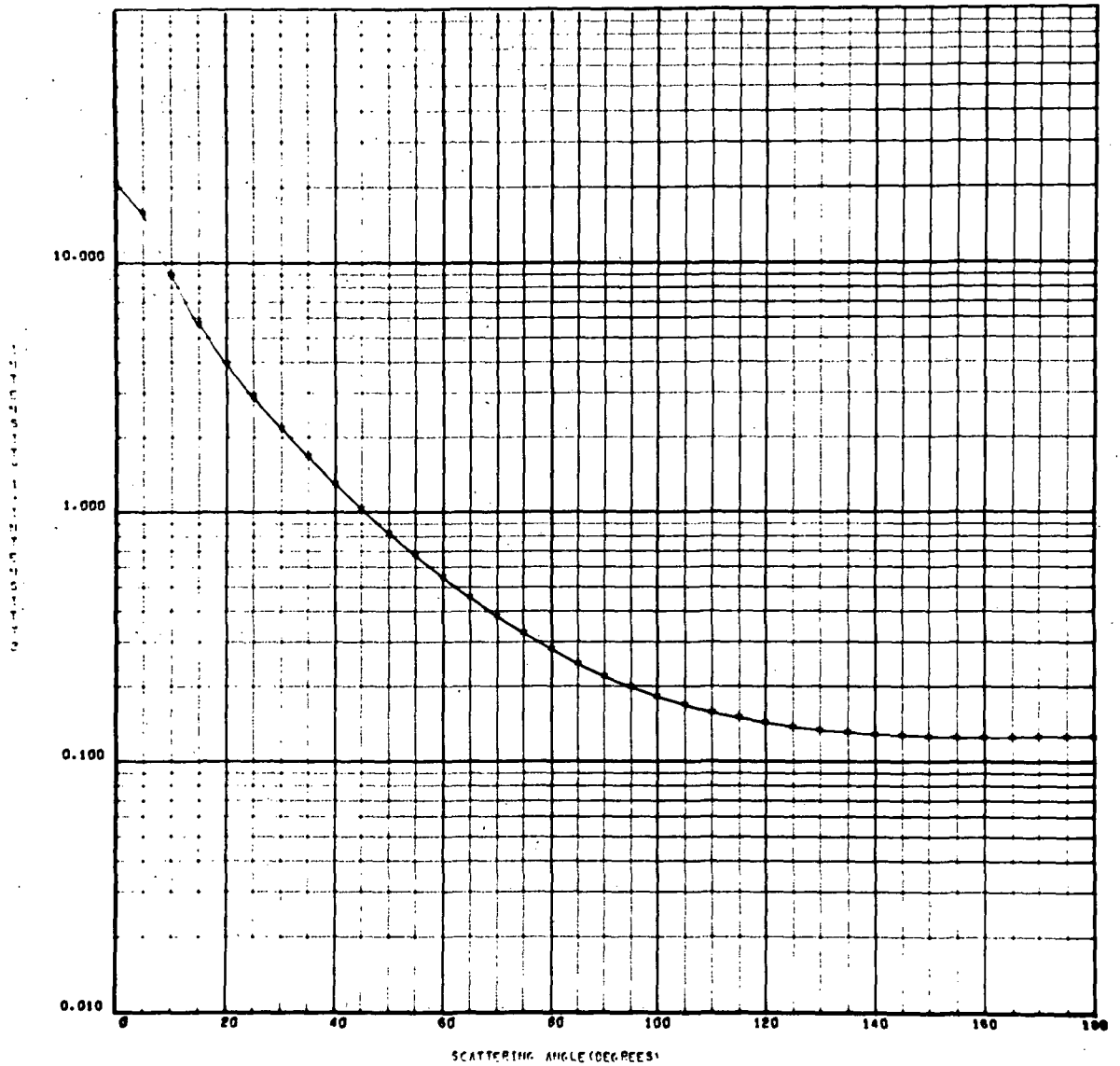


Figure 30. Intensity versus scattering angle  
for graphite with  $1 \leq \alpha \leq 20$ .

GRAPHITE  
 $M = 1.59 - 0.66i$   
 $1 \leq \alpha \leq 15$

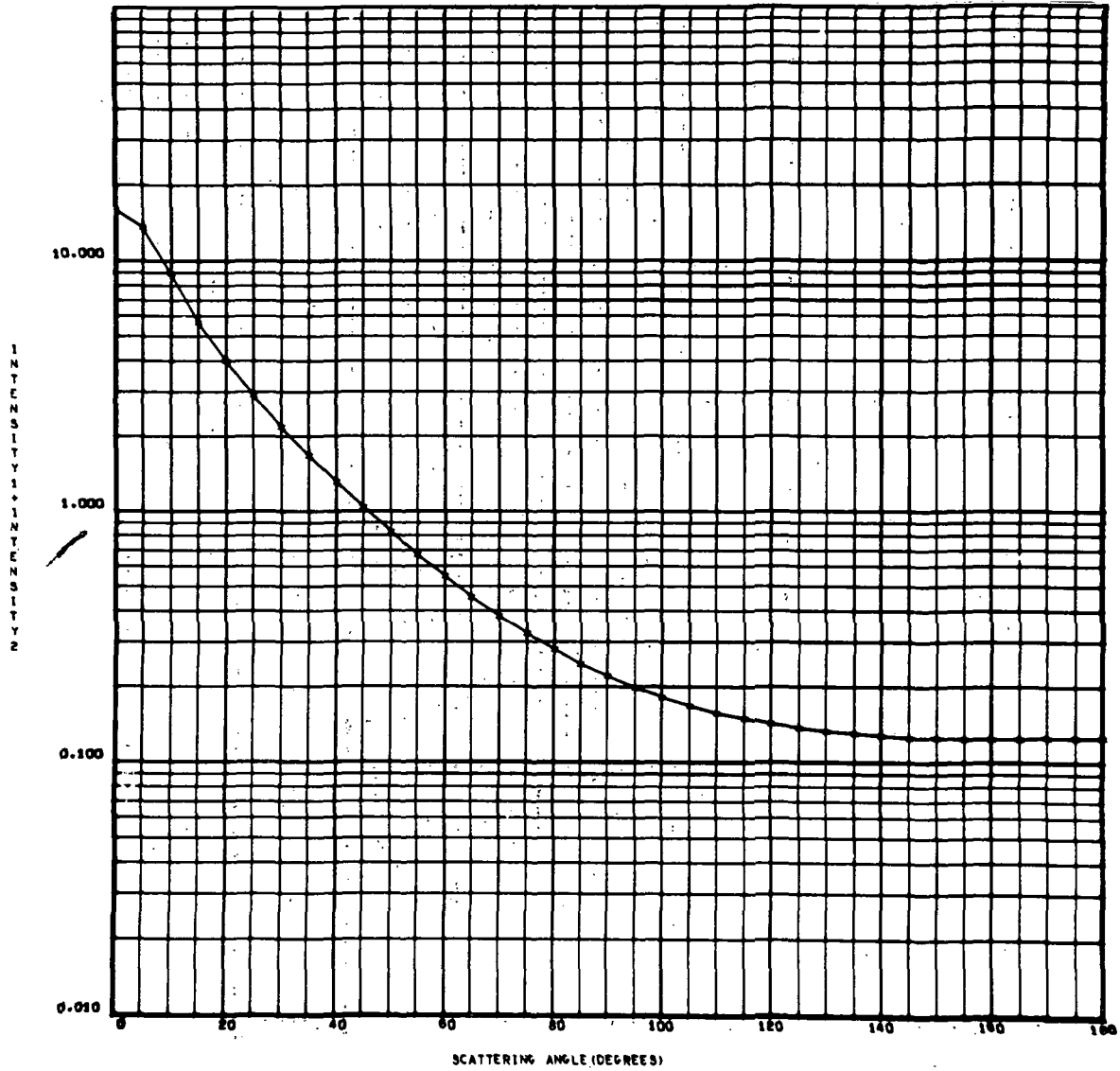


Figure 29. Intensity versus scattering angle  
for graphite with  $1 \leq \alpha \leq 15$ .

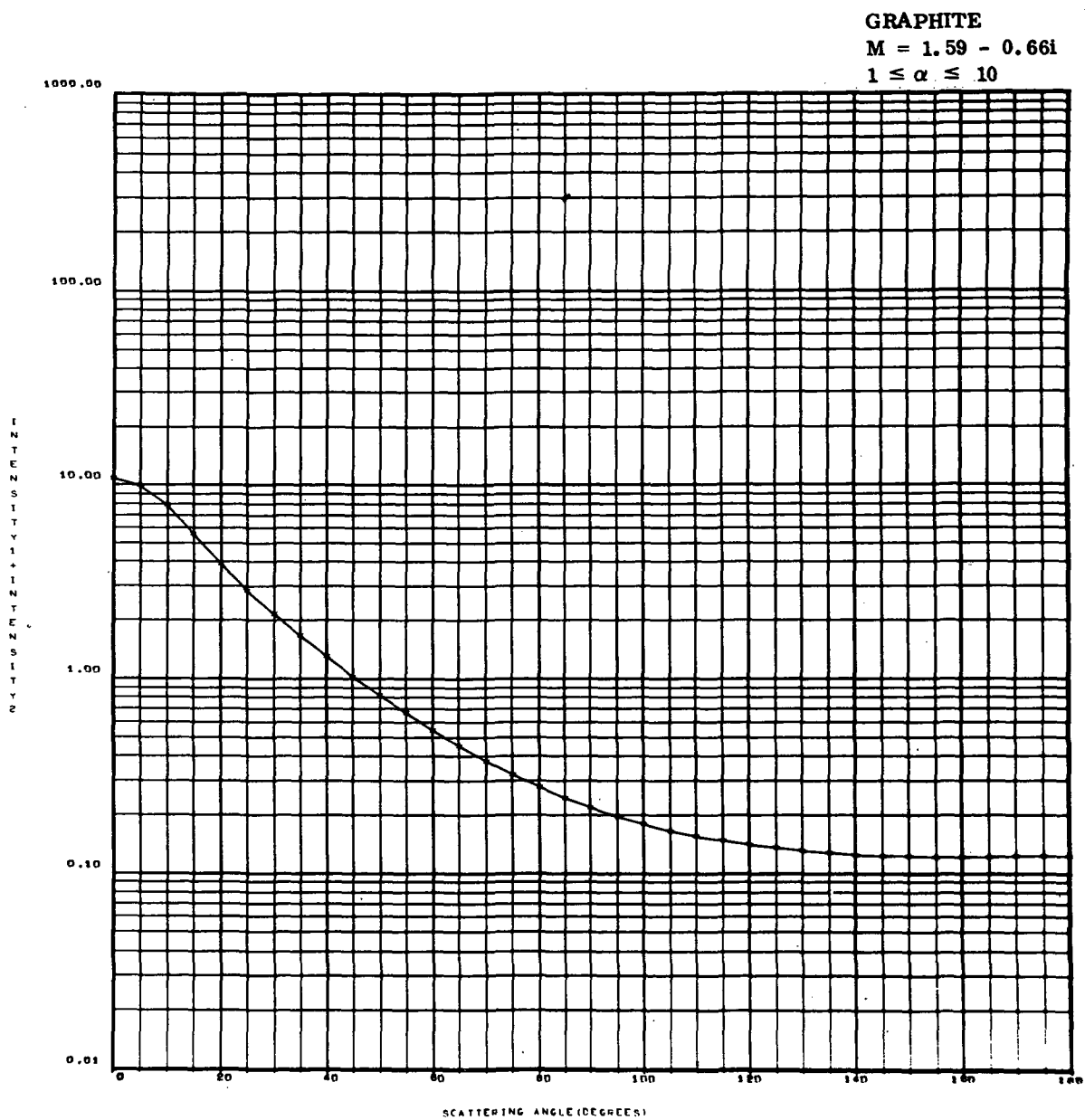


Figure 28. Intensity versus scattering angle  
for graphite with  $1 \leq \alpha \leq 10$ .

GRAPHITE  
 $M = 1.59 - 0.66i$   
 $1 \leq \alpha \leq 5$

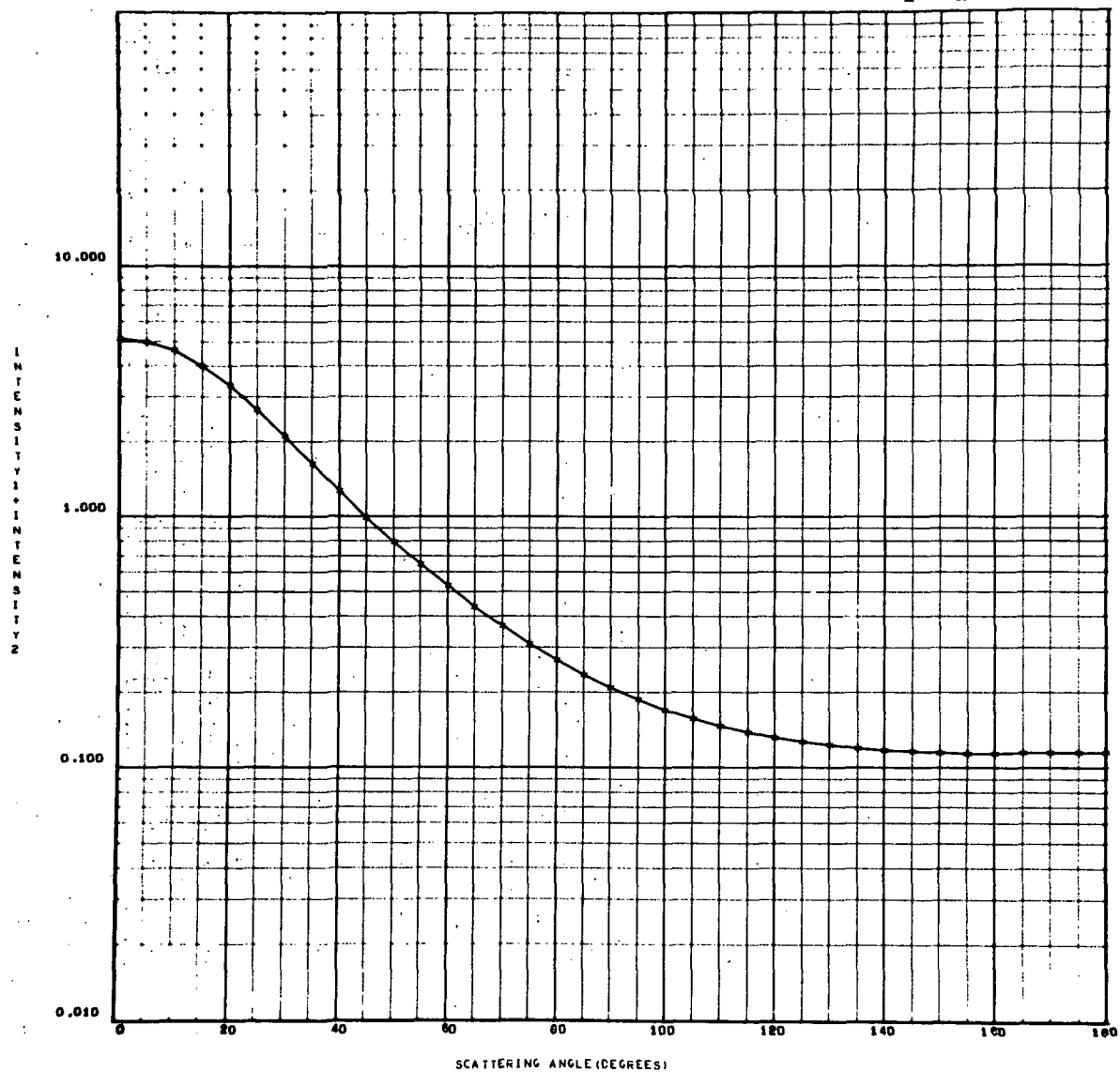


Figure 27. Intensity versus scattering angle  
for graphite with  $1 \leq \alpha \leq 5$ .



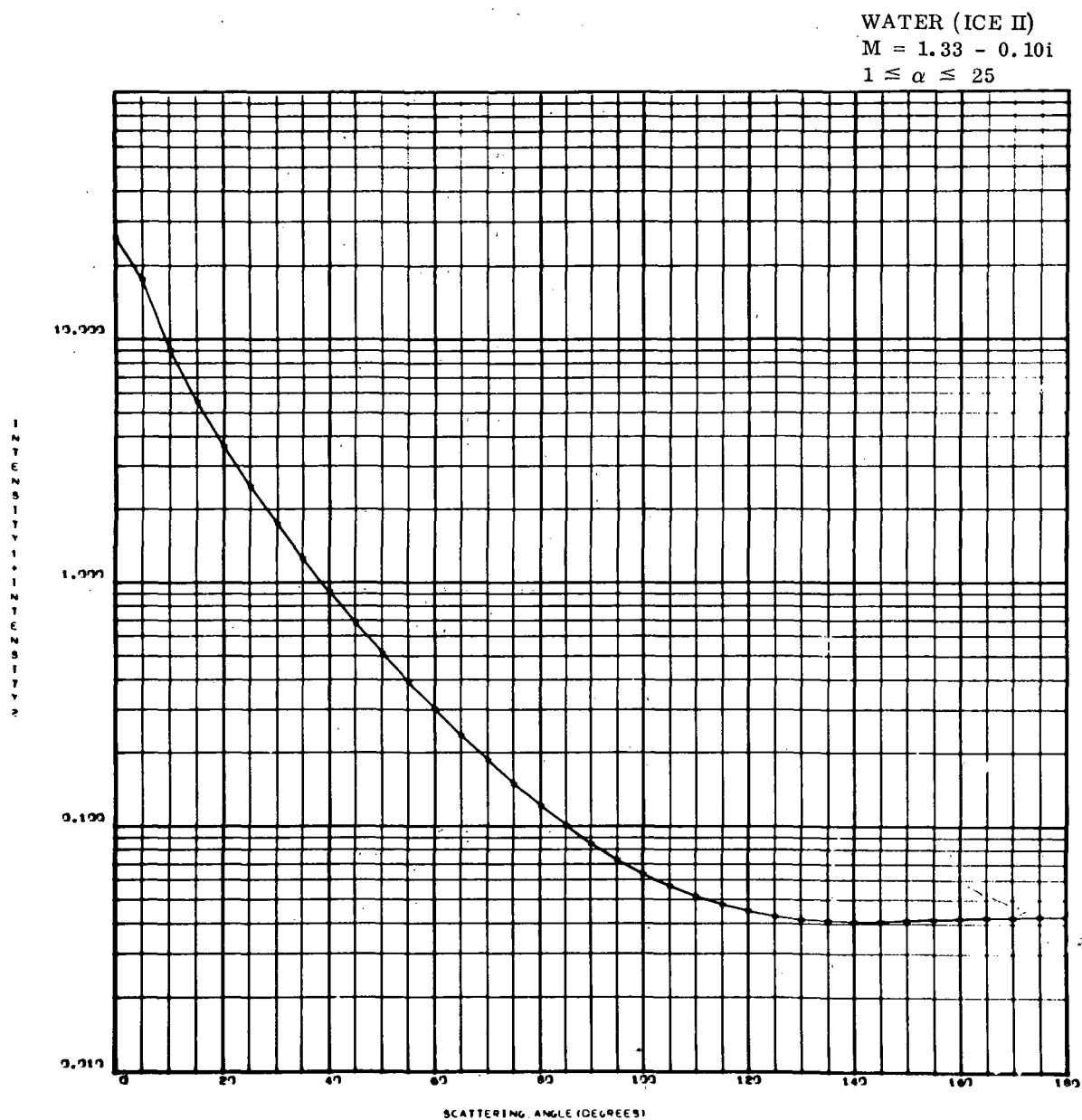


Figure 26. Intensity versus scattering angle  
for water (ice II) with  $1 \leq \alpha \leq 25$ .

WATER (ICE II)  
 $M = 1.33 - 0.10i$   
 $1 \leq \alpha \leq 20$

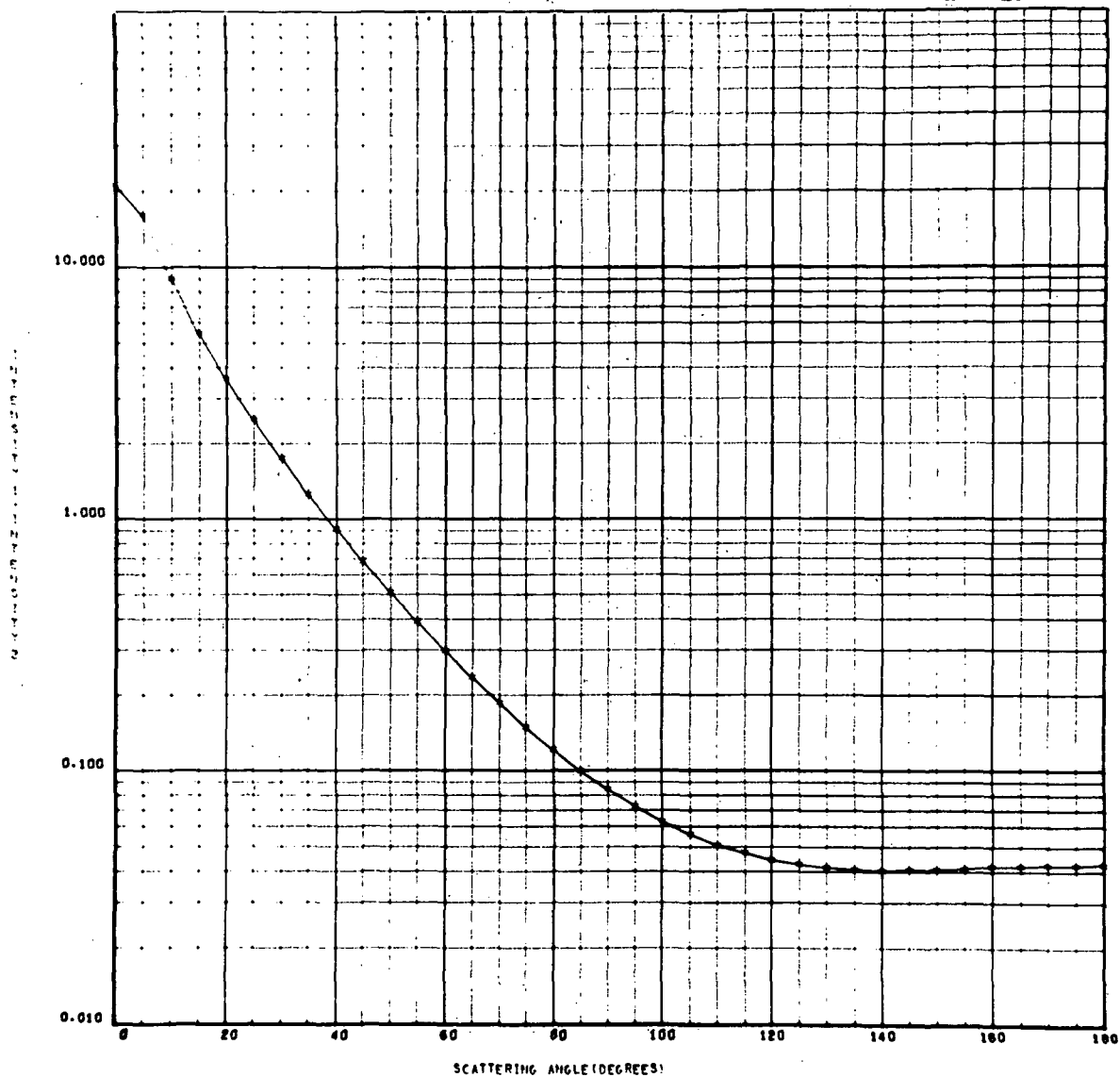


Figure 25. Intensity versus scattering angle  
for water (ice II) with  $1 \leq \alpha \leq 20$ .

WATER (ICE II)  
 $M = 1.33 - 0.10i$   
 $1 \leq \alpha \leq 15$

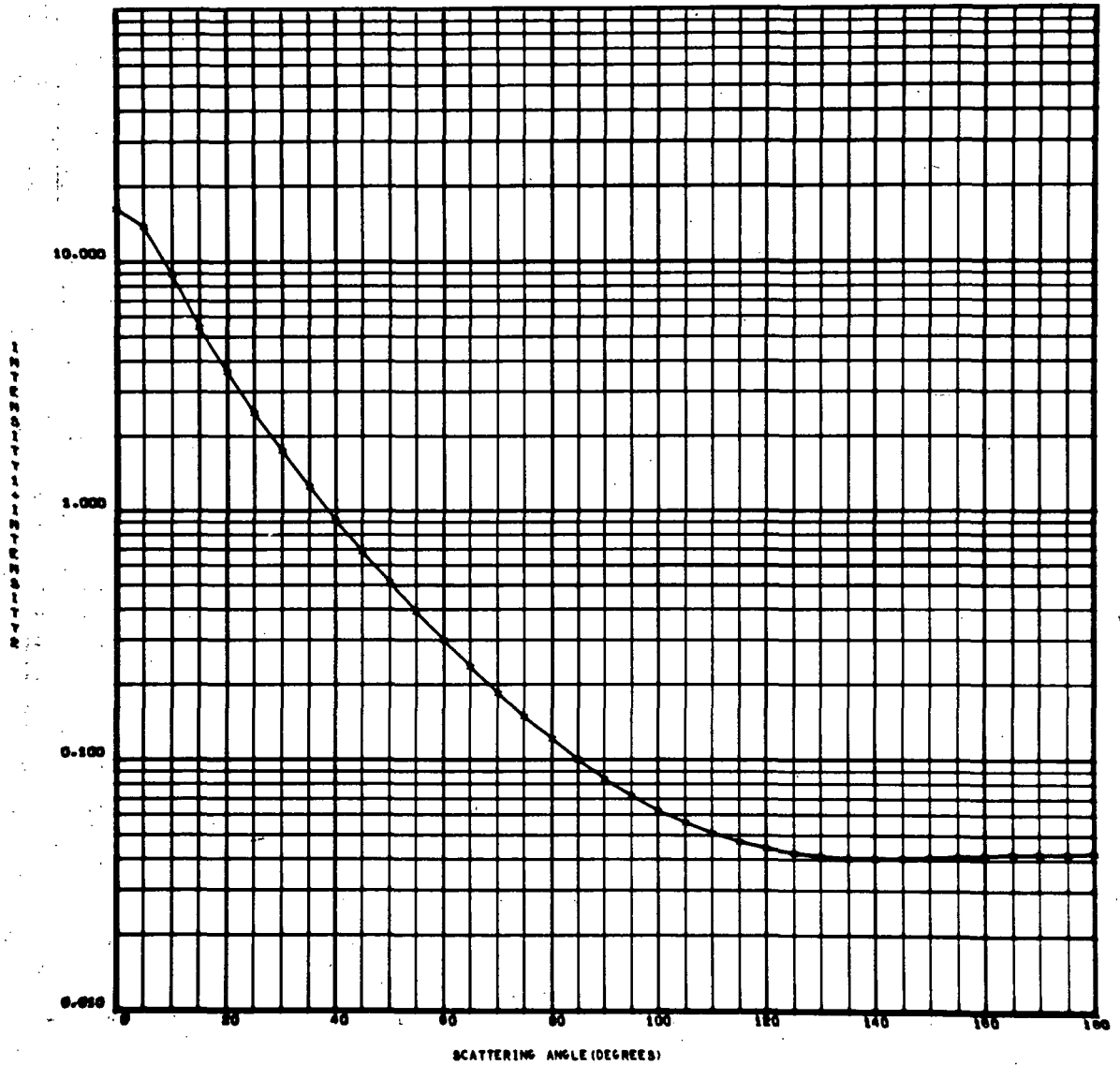


Figure 24. Intensity versus scattering angle  
for water (ice II) with  $1 \leq \alpha \leq 15$ .

WATER (ICE II)  
 $M = 1.33 - 0.10i$   
 $1 \leq \alpha \leq 10$

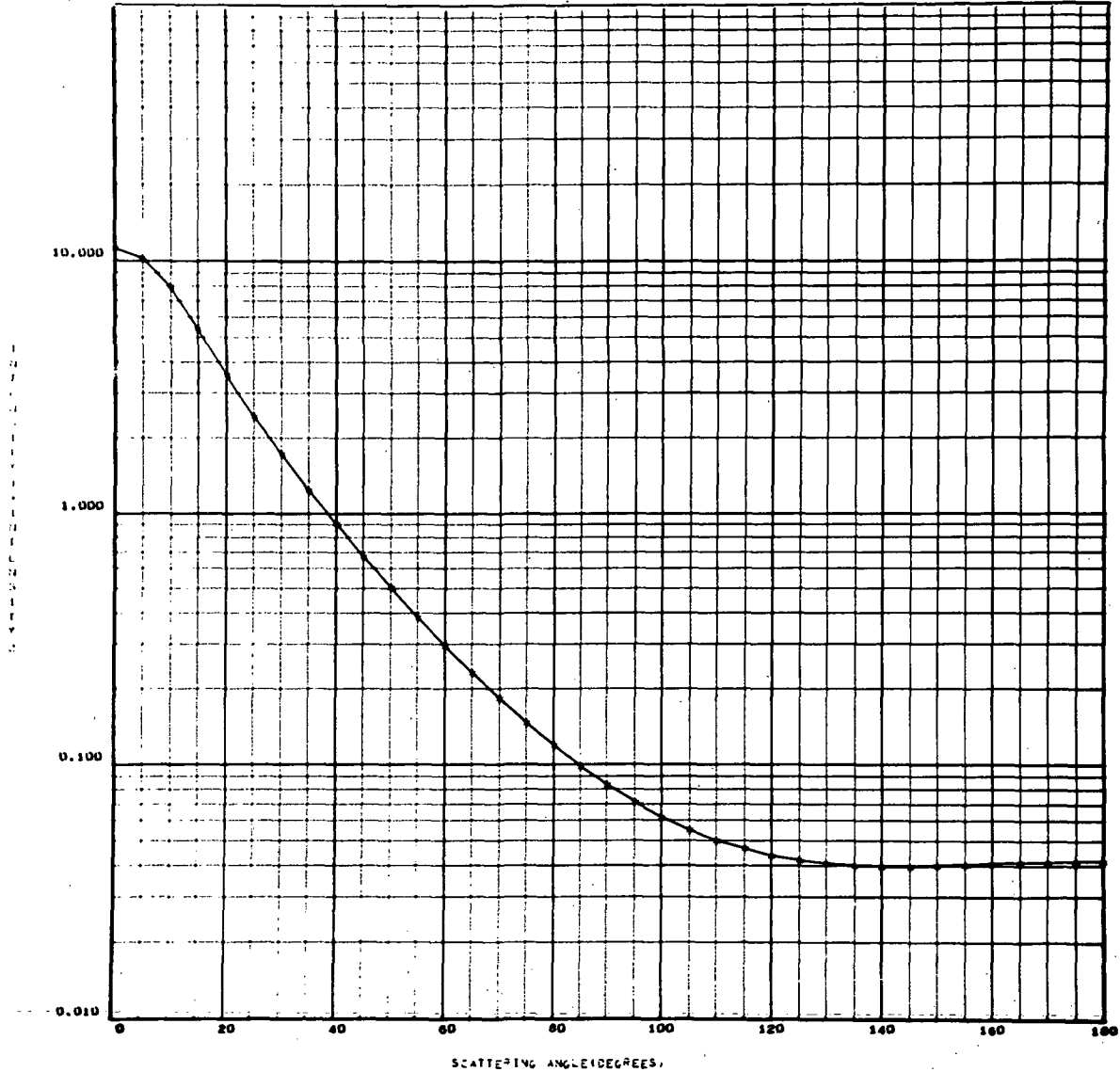


Figure 23. Intensity versus scattering angle  
for water (ice II) with  $1 \leq \alpha \leq 10$ .

WATER (ICE II)  
 $M = 1.33 - 0.10i$   
 $1 \leq \alpha \leq 5$

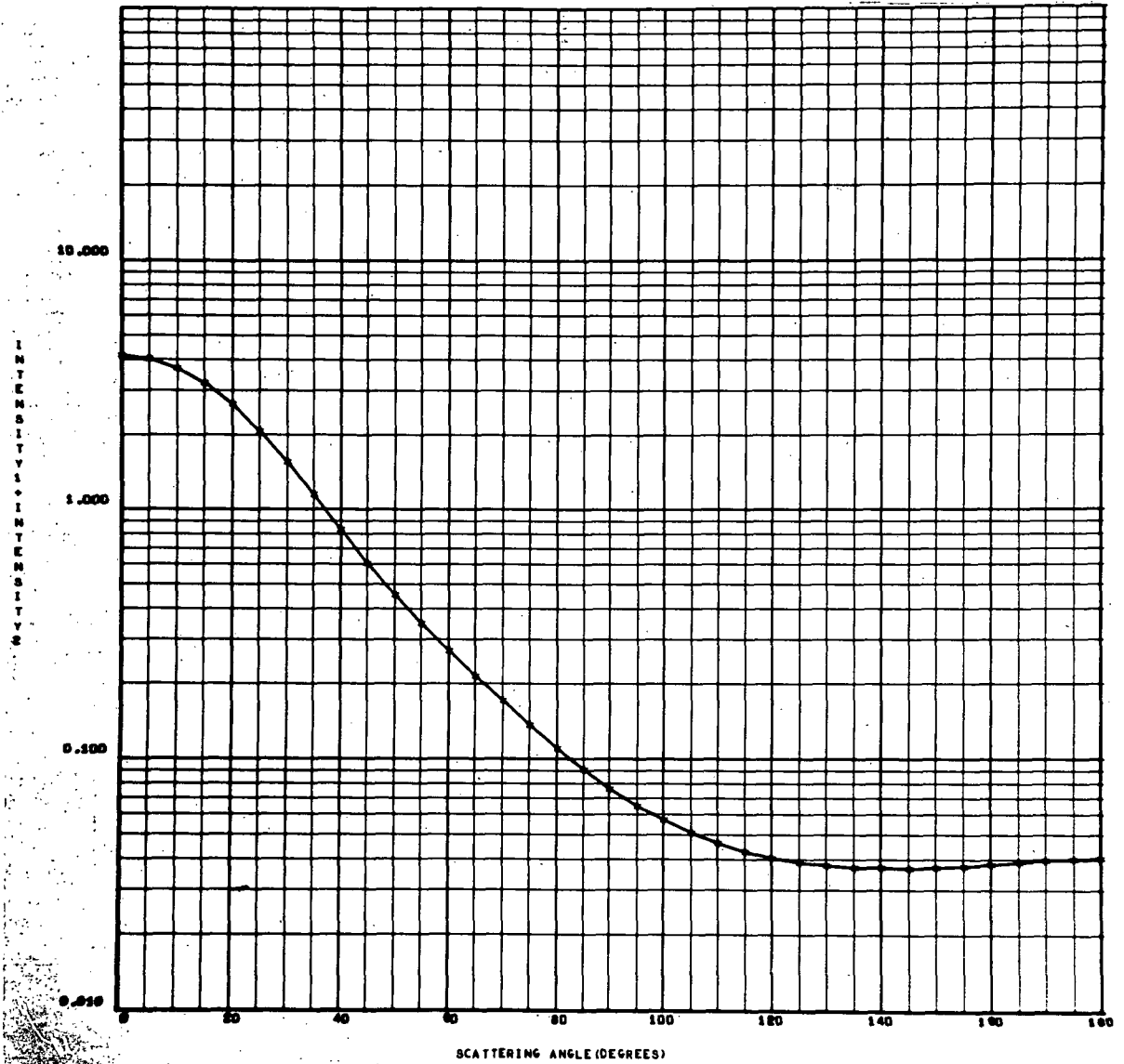


Figure 22. Intensity versus scattering angle  
for water (ice II) with  $1 \leq \alpha \leq 5$ .

WATER (ICE I)

$M = 1.33 - 0.05i$

$1 \leq \alpha \leq 25$

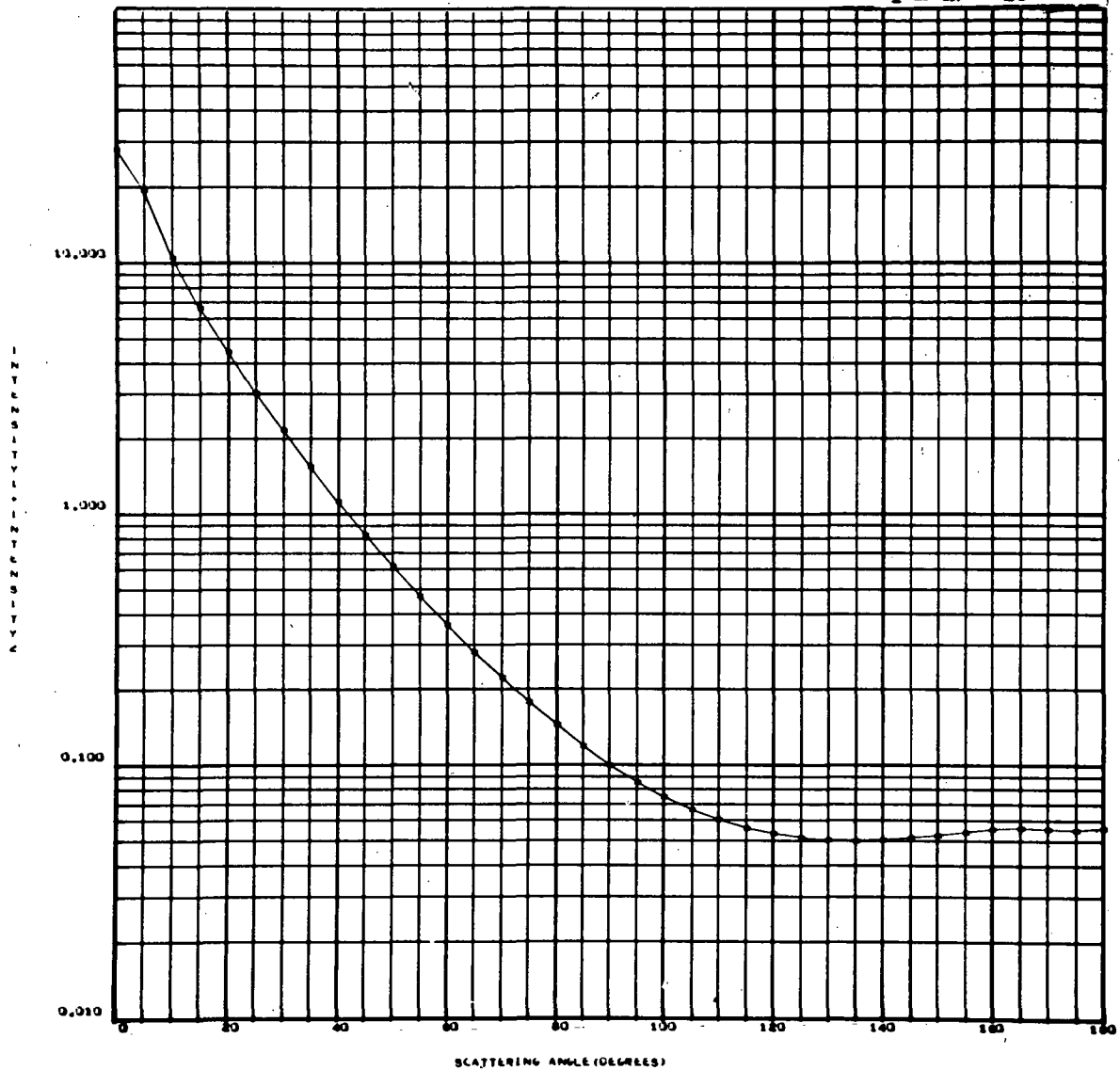


Figure 21. Intensity versus scattering angle  
for water (ice I) with  $1 \leq \alpha \leq 25$ .

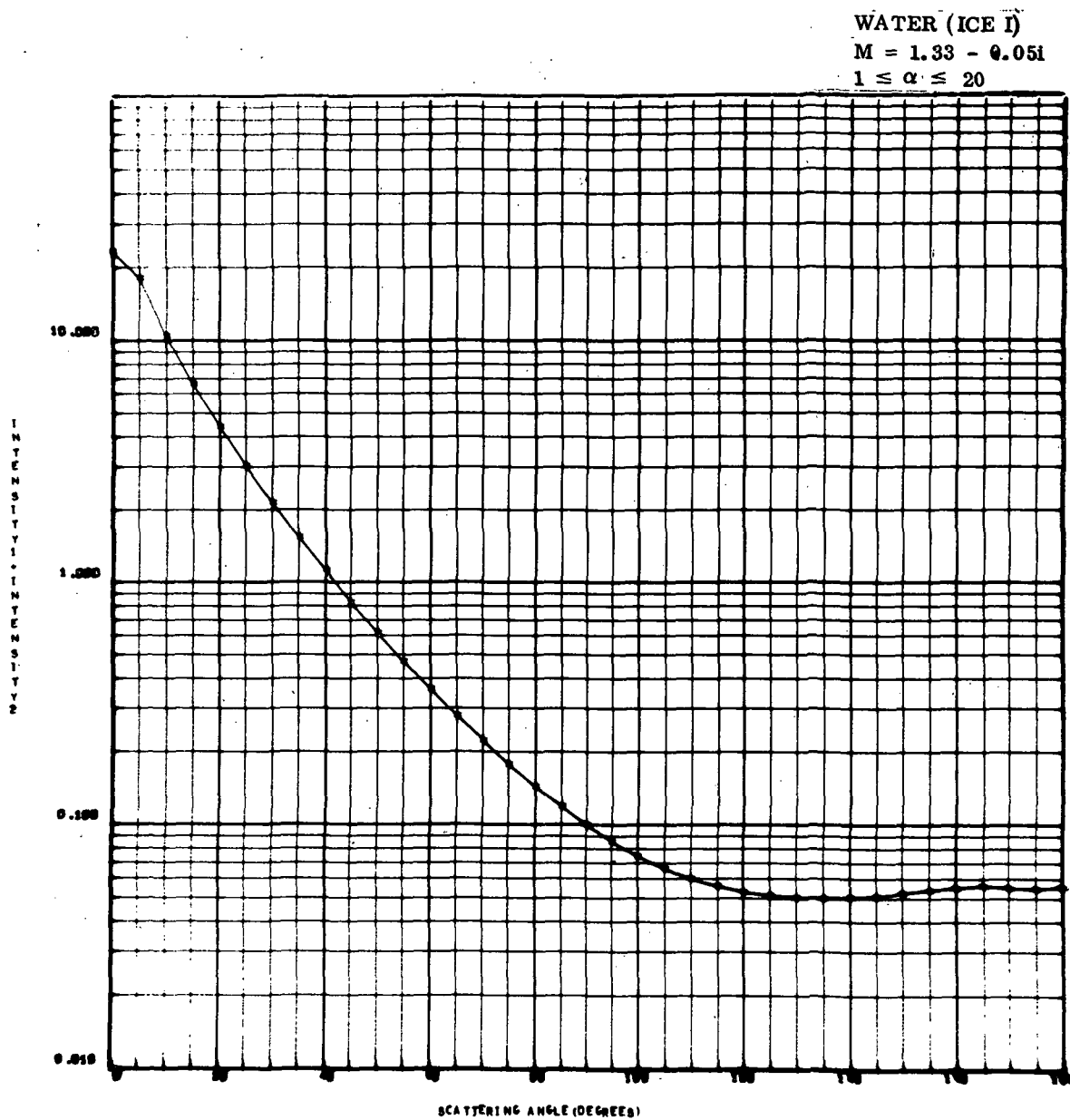


Figure 20. Intensity versus scattering angle  
for water (ice I) with  $1 \leq \alpha \leq 20$ .

WATER (ICE I)  
 $M = 1.33 - 0.05i$   
 $1 \leq \alpha \leq 15$

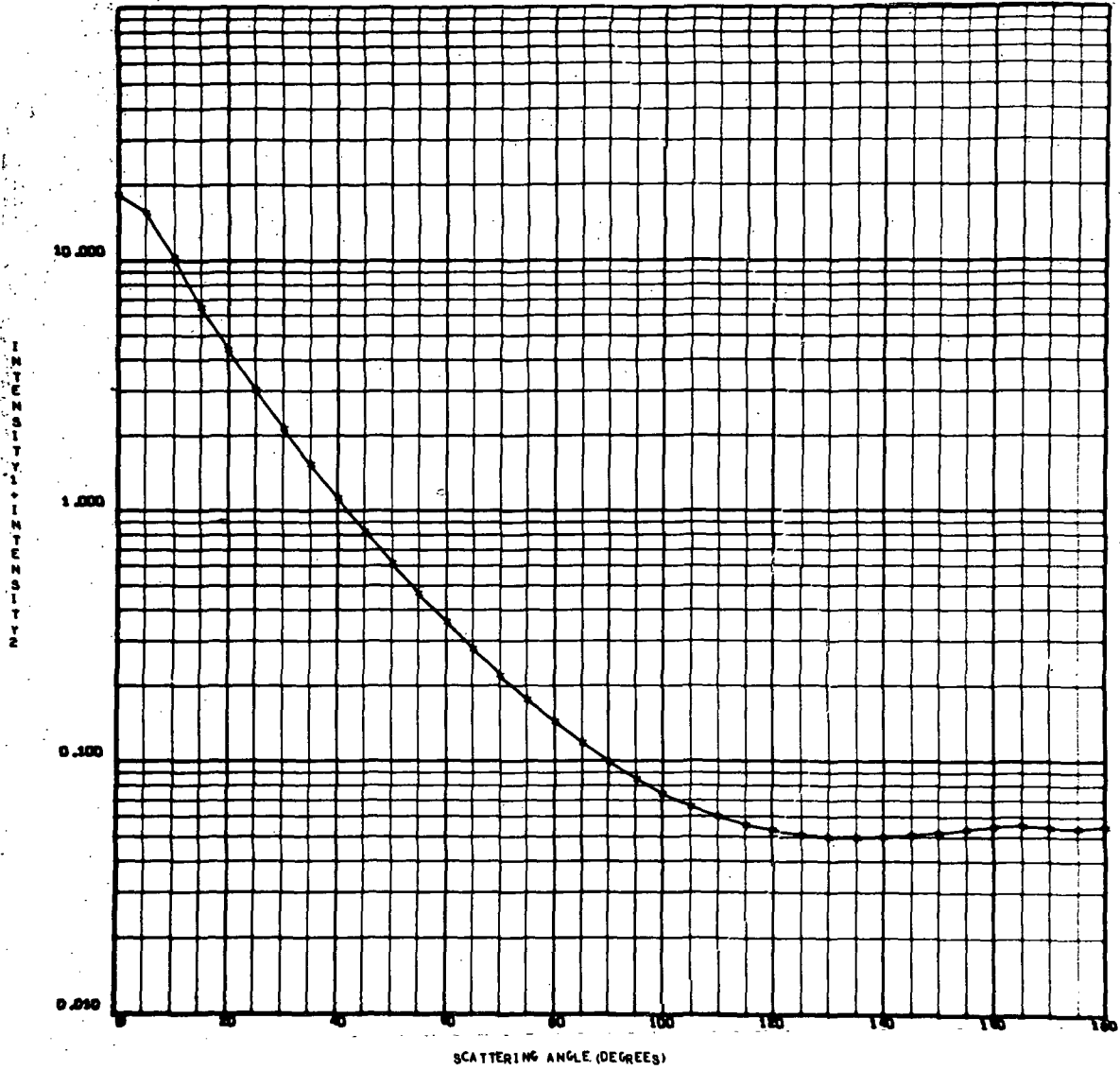


Figure 19. Intensity versus scattering angle  
for water (ice I) with  $1 \leq \alpha \leq 15$ .



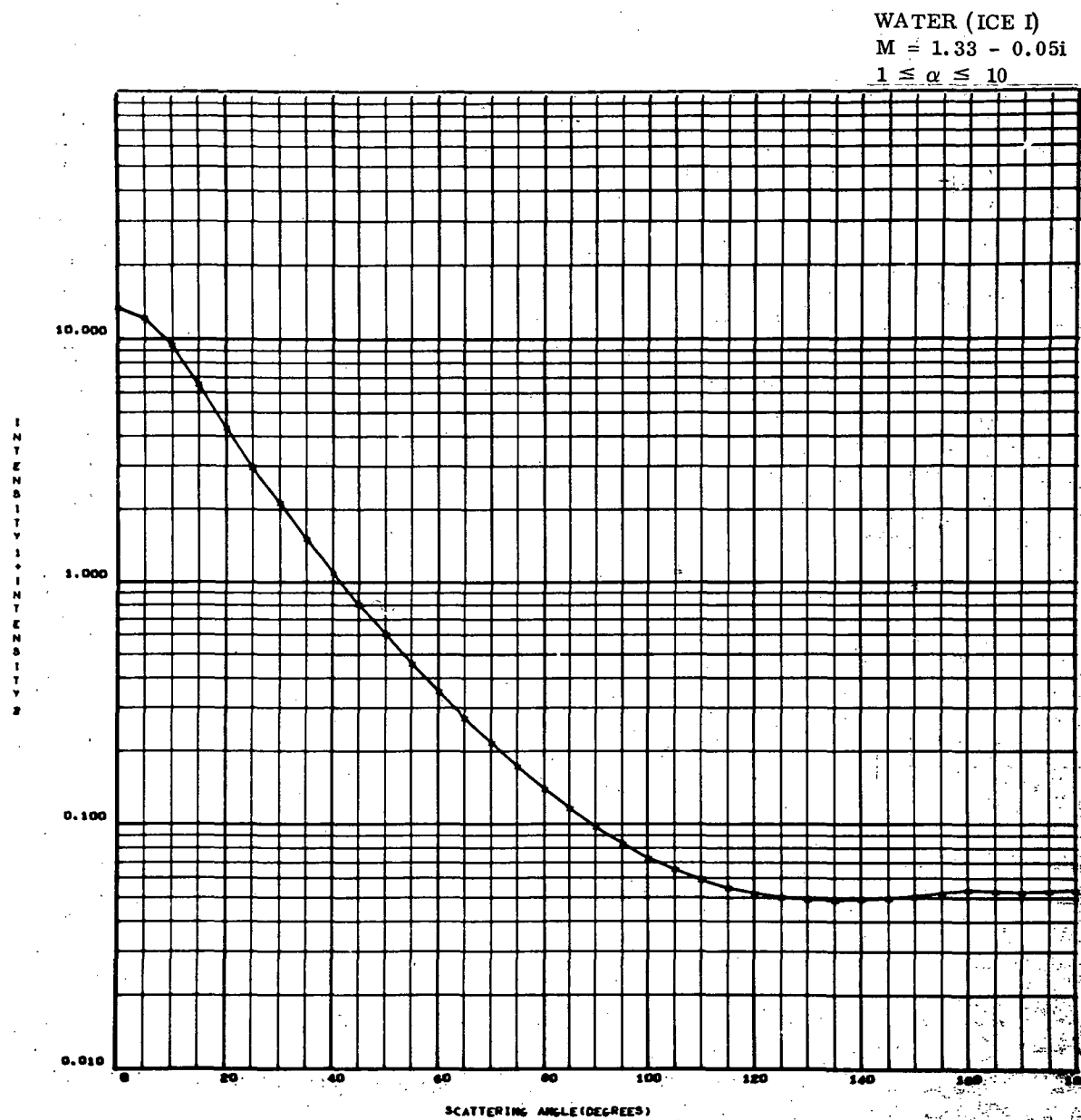


Figure 18. Intensity versus scattering angle  
for water (ice I) with  $1 \leq \alpha \leq 10$ .

WATER (ICE I)  
 $M = 1.33 - 0.05i$   
 $1 \leq \alpha \leq 5$

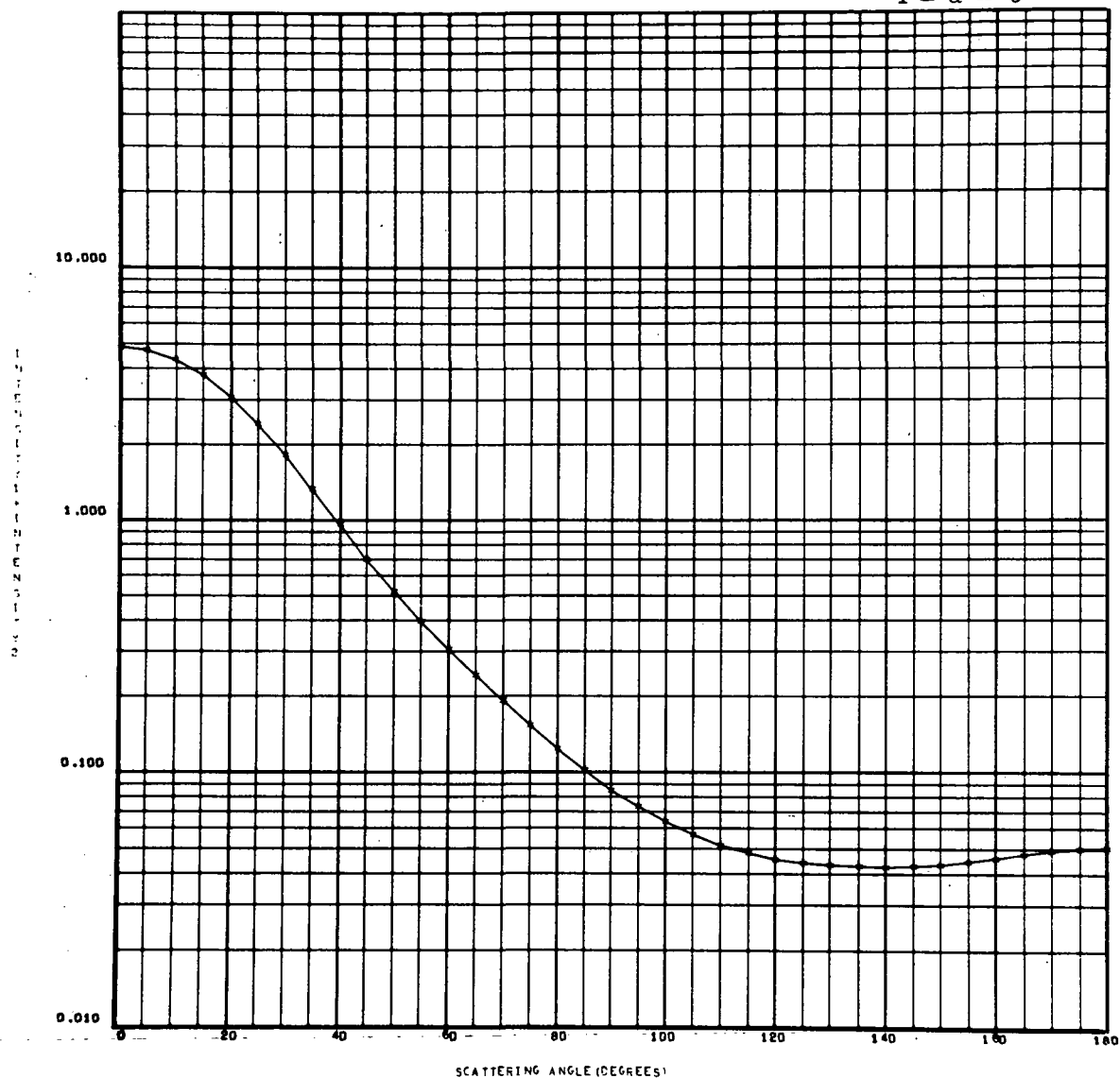


Figure 17. Intensity versus scattering angle  
for water (ice I) with  $1 \leq \alpha \leq 5$ .

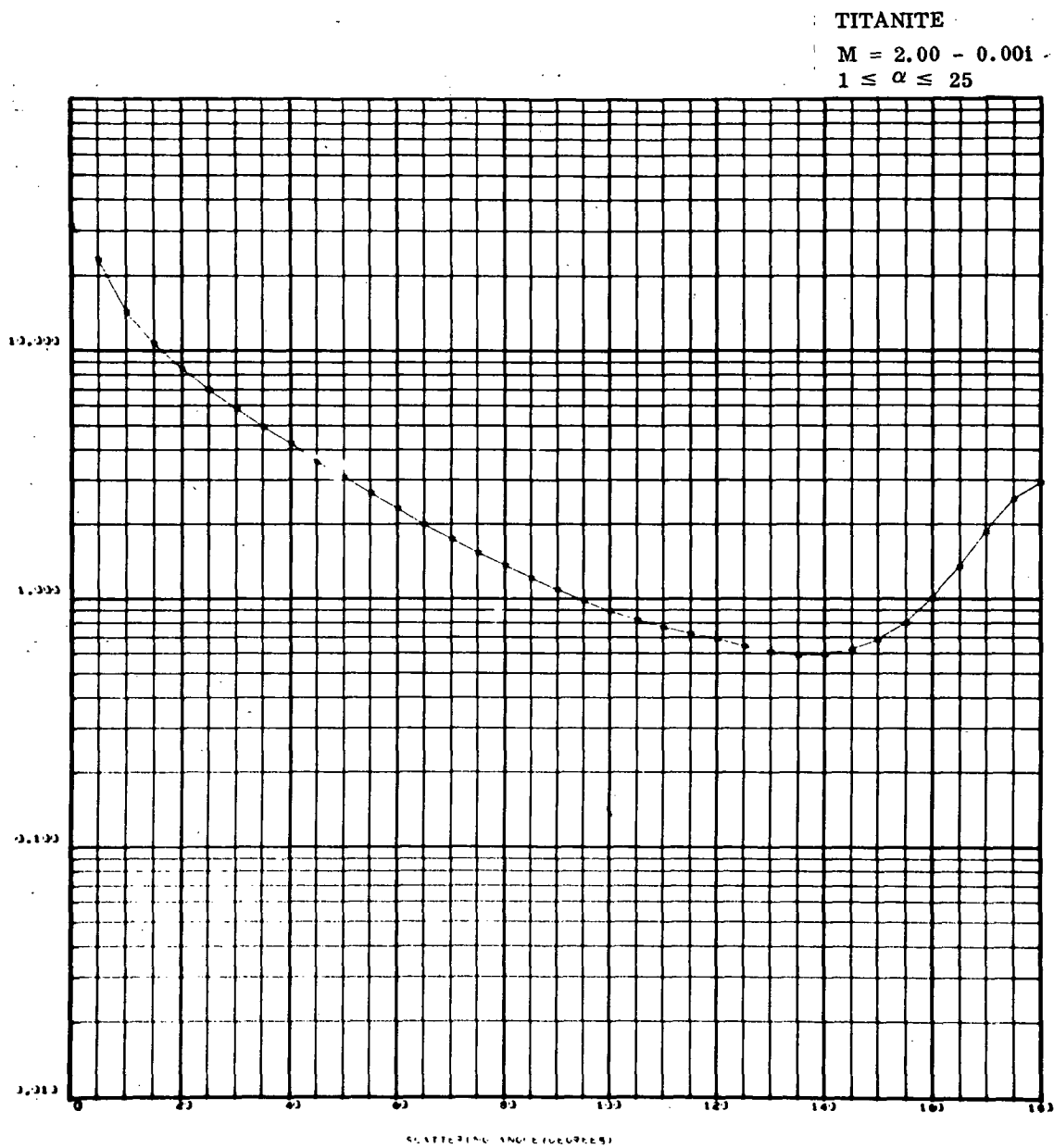


Figure 16. Intensity versus scattering angle  
for titanite with  $1 \leq \alpha \leq 25$ .

TITANITE

$M = 2.00 - 0.00i$

$1 \leq \alpha \leq 20$

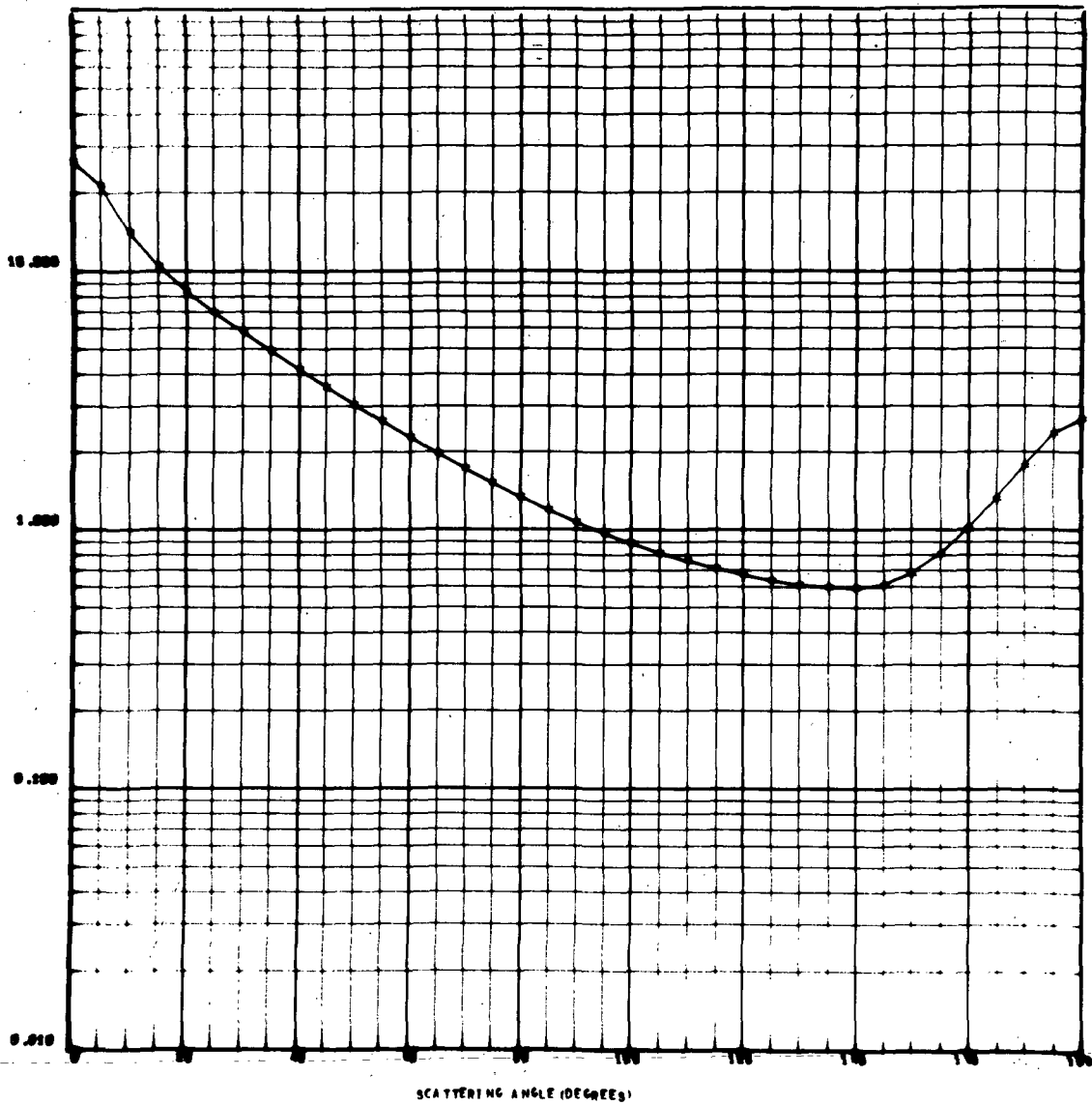


Figure 15. Intensity versus scattering angle  
for titanite with  $1 \leq \alpha \leq 20$ .

TITANITE  
 $M = 2.00 - 0.00i$   
 $1 \leq \alpha \leq 15$

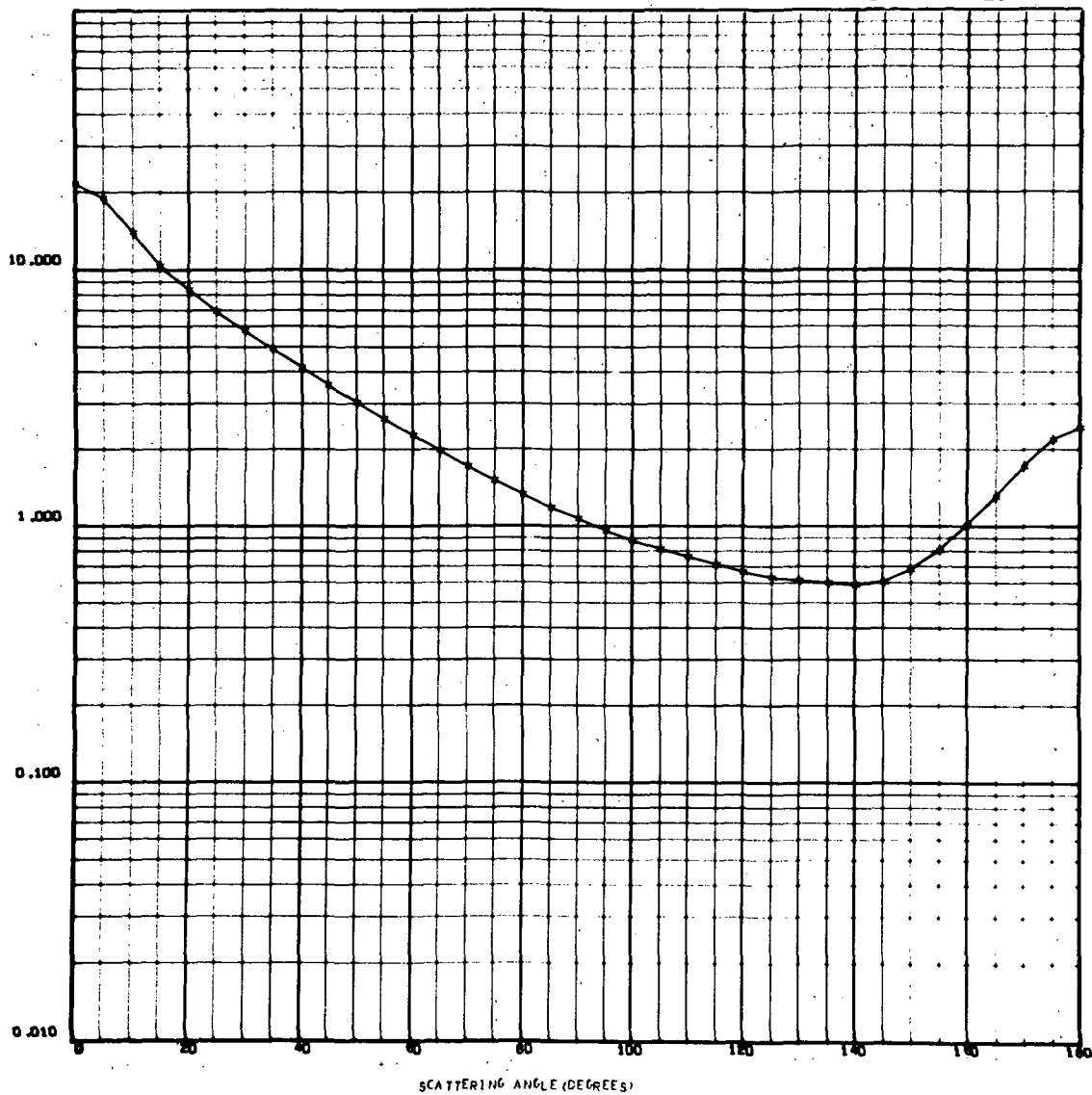


Figure 14. Intensity versus scattering angle  
for titanite with  $1 \leq \alpha \leq 15$ .

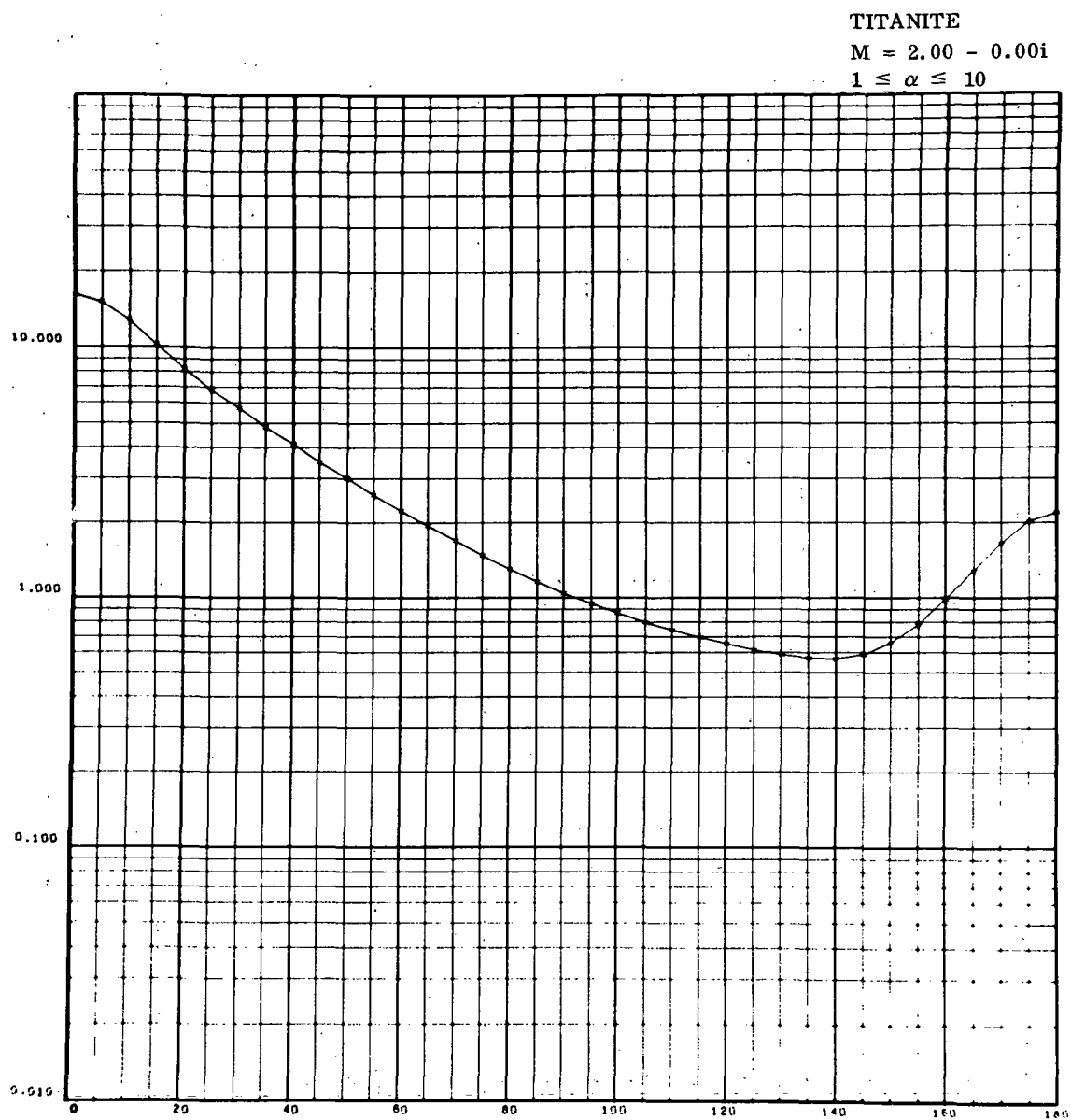


Figure 13. Intensity versus scattering angle  
for titanite with  $1 \leq \alpha \leq 10$ .

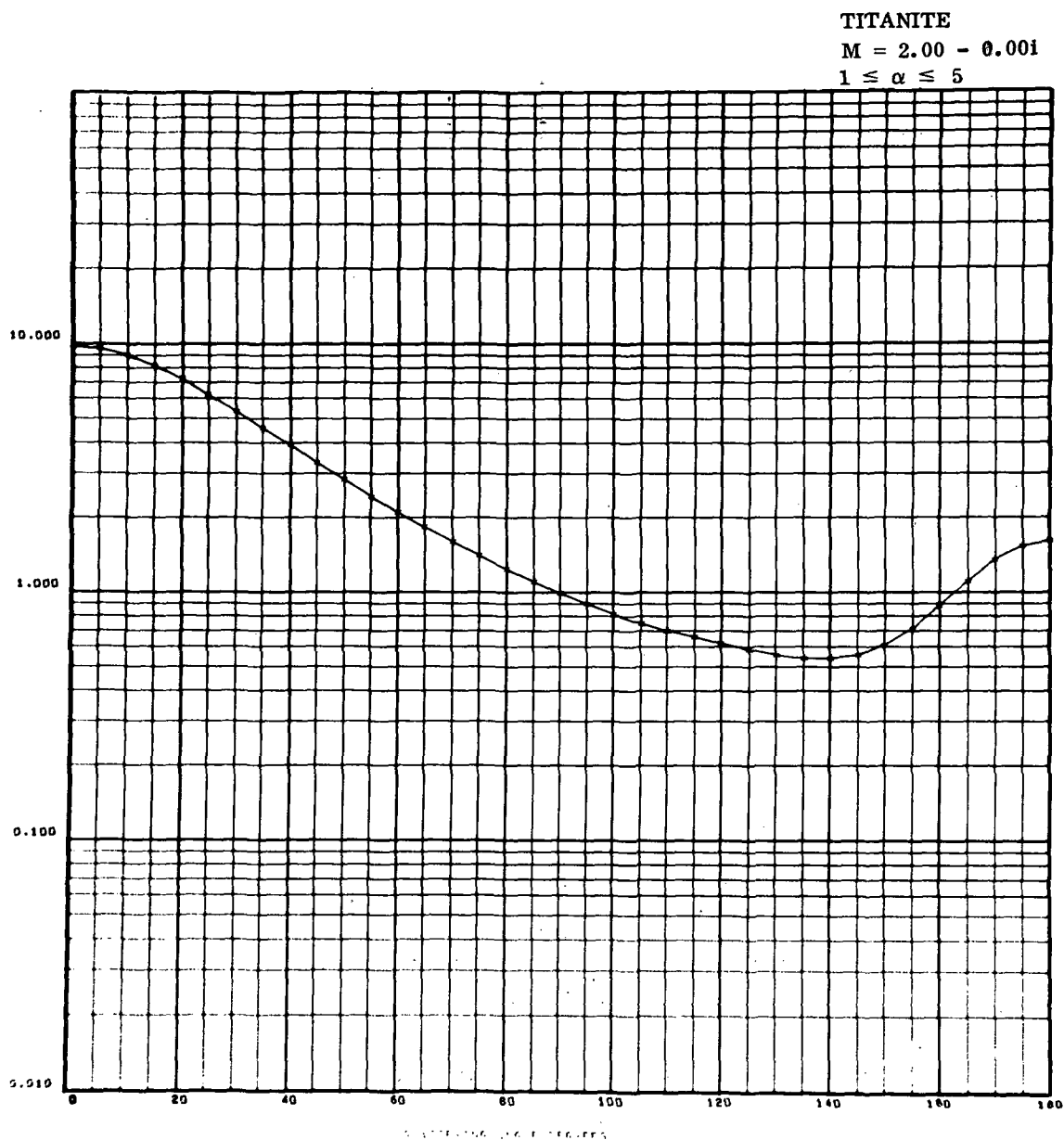


Figure 12. Intensity versus scattering angle  
for titanite with  $1 \leq \alpha \leq 5$ .

WATER (ICE)  
 $M = 1.33 - 0.00i$   
 $1 \leq \alpha \leq 25$

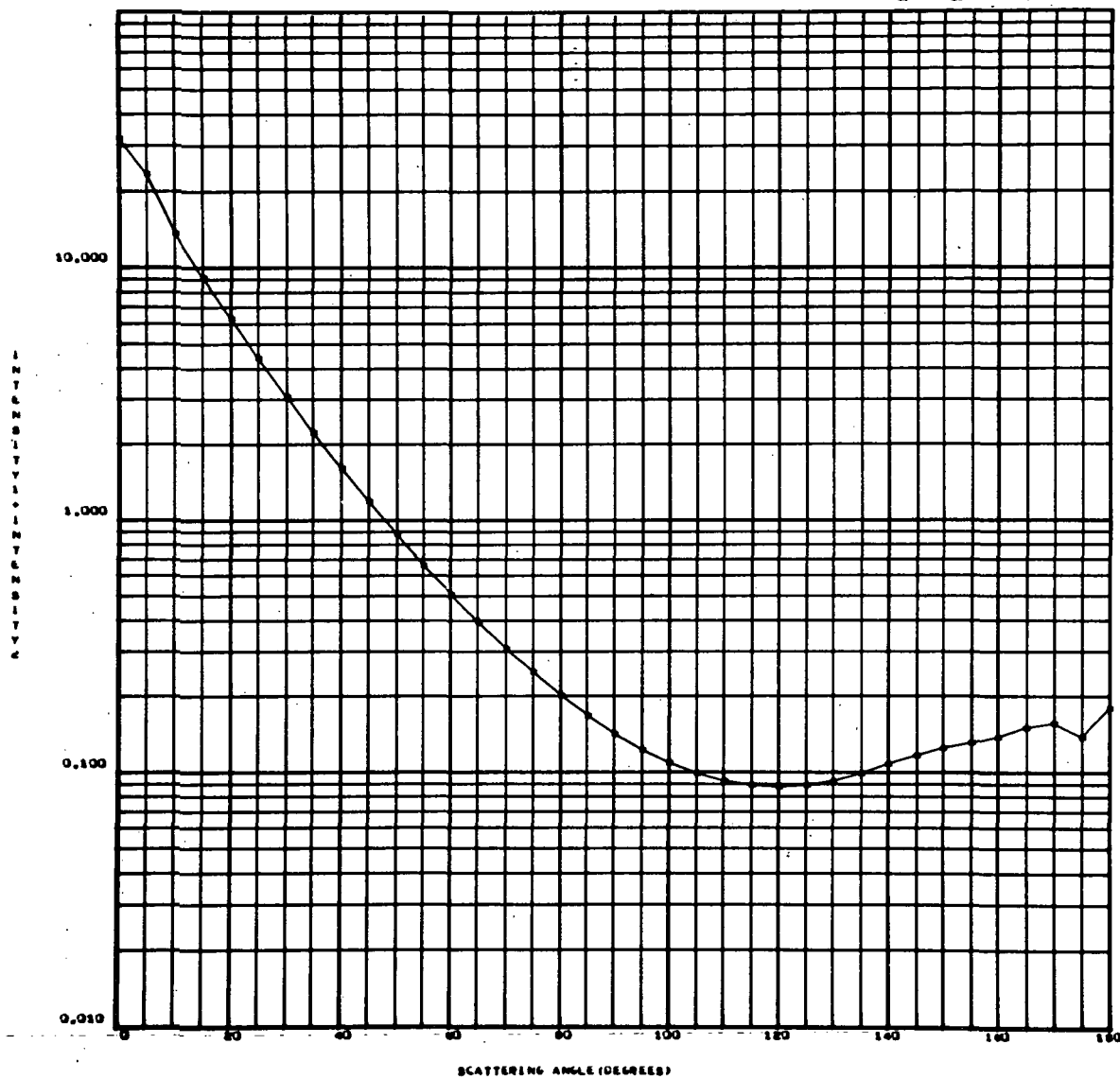


Figure 11. Intensity versus scattering angle  
for water (ice) with  $1 \leq \alpha \leq 25$ .



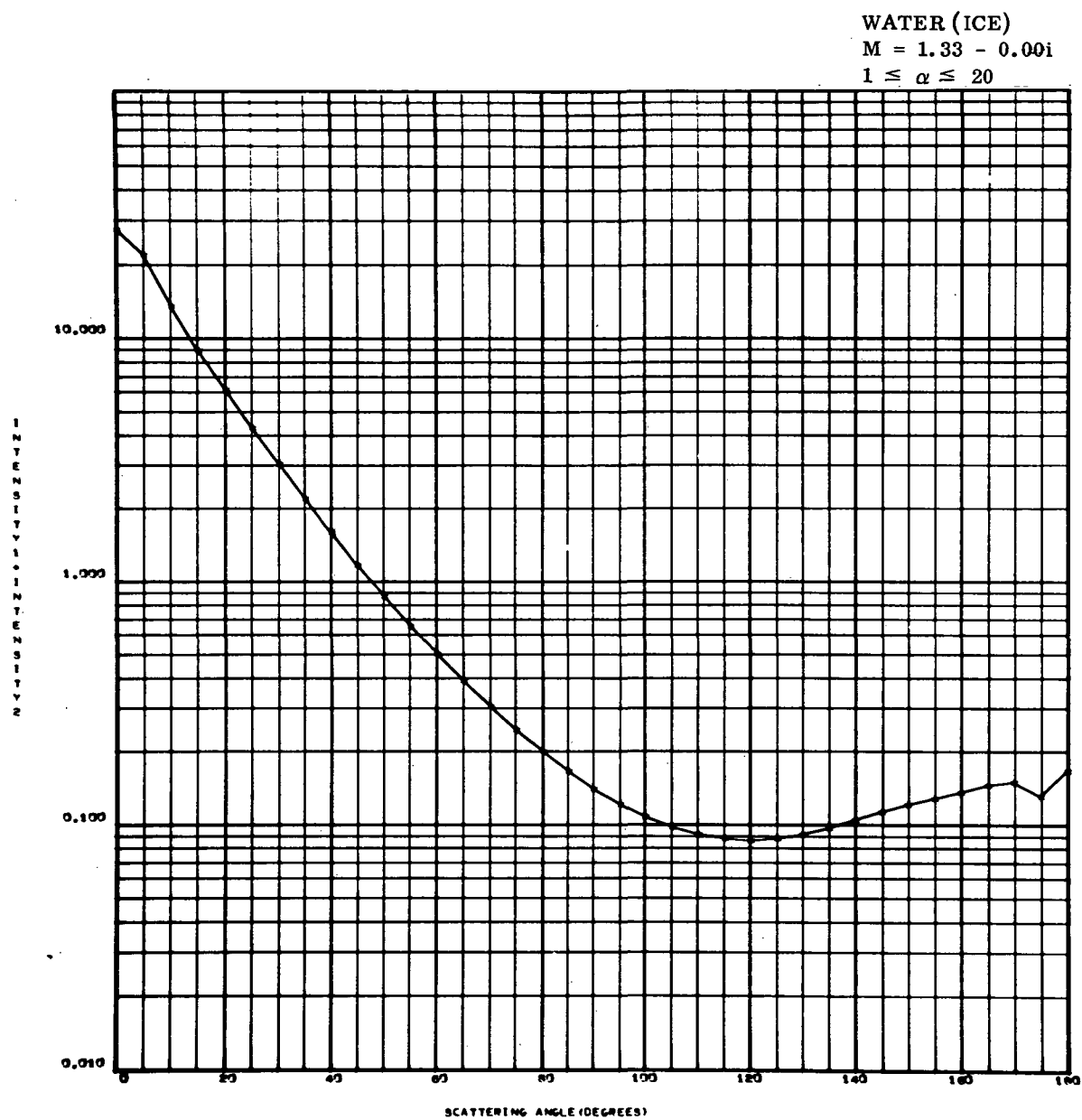


Figure 10. Intensity versus scattering angle  
for water (ice) with  $1 \leq \alpha \leq 20$ .

WATER (ICE)  
 $M = 1.33 - 0.001i$   
 $1 \leq \alpha \leq 15$

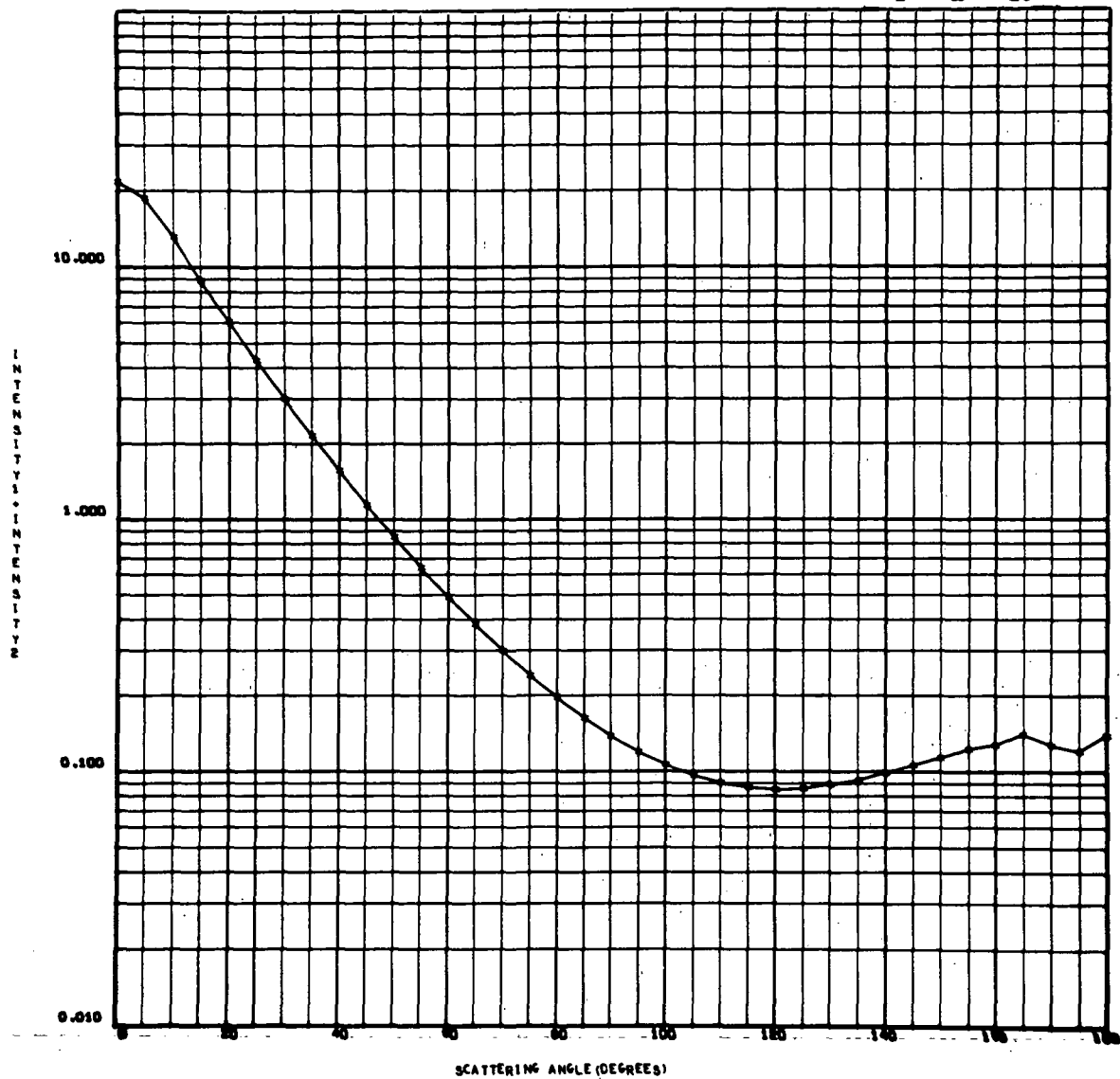


Figure 9. Intensity versus scattering angle  
for water (ice) with  $1 \leq \alpha \leq 15$ .

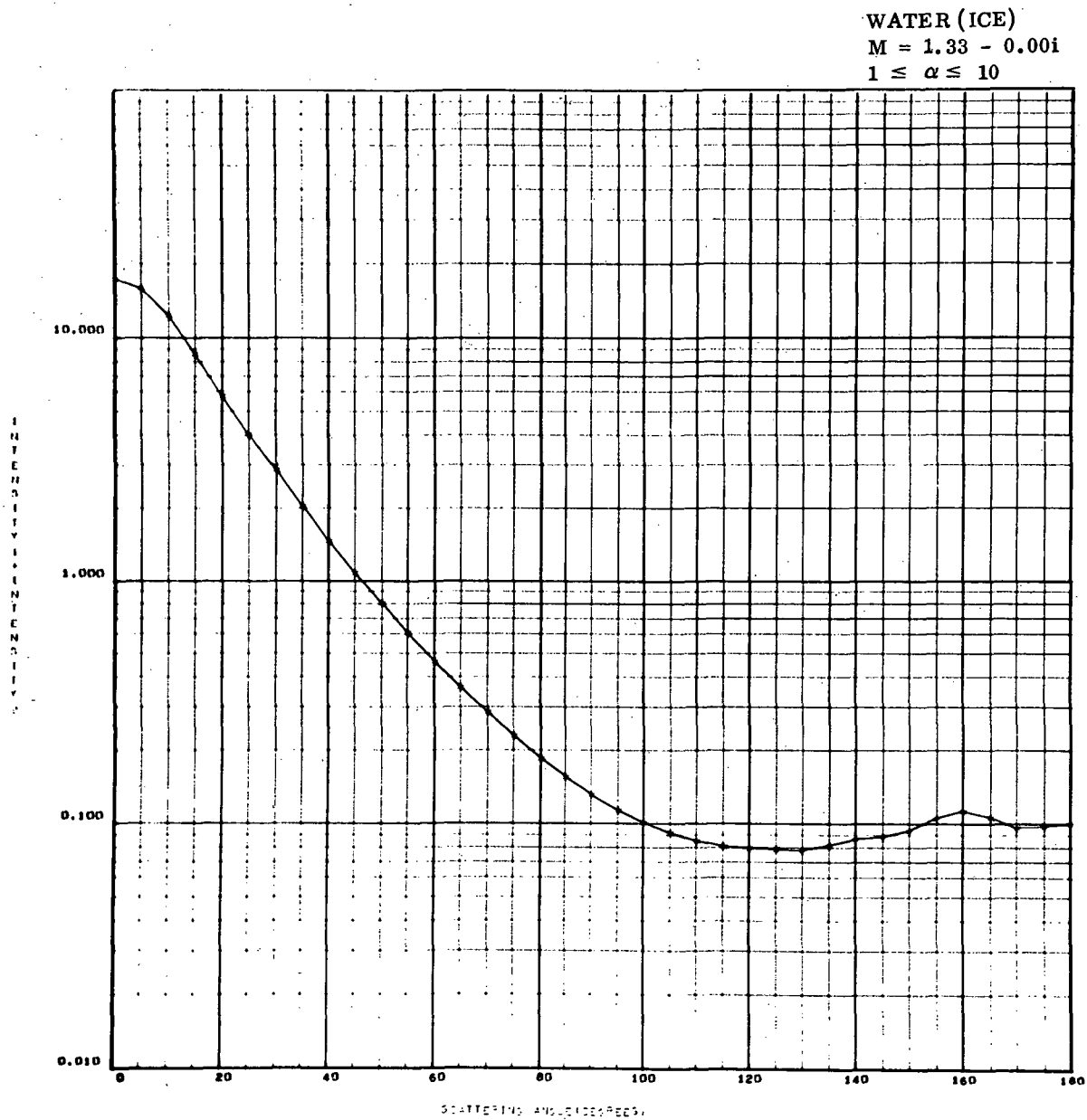


Figure 8. Intensity versus scattering angle  
for water (ice) with  $1 \leq \alpha \leq 10$ .

WATER (ICE)  
 $M = 1.33 - 0.00i$   
 $1 \leq \alpha \leq 5$

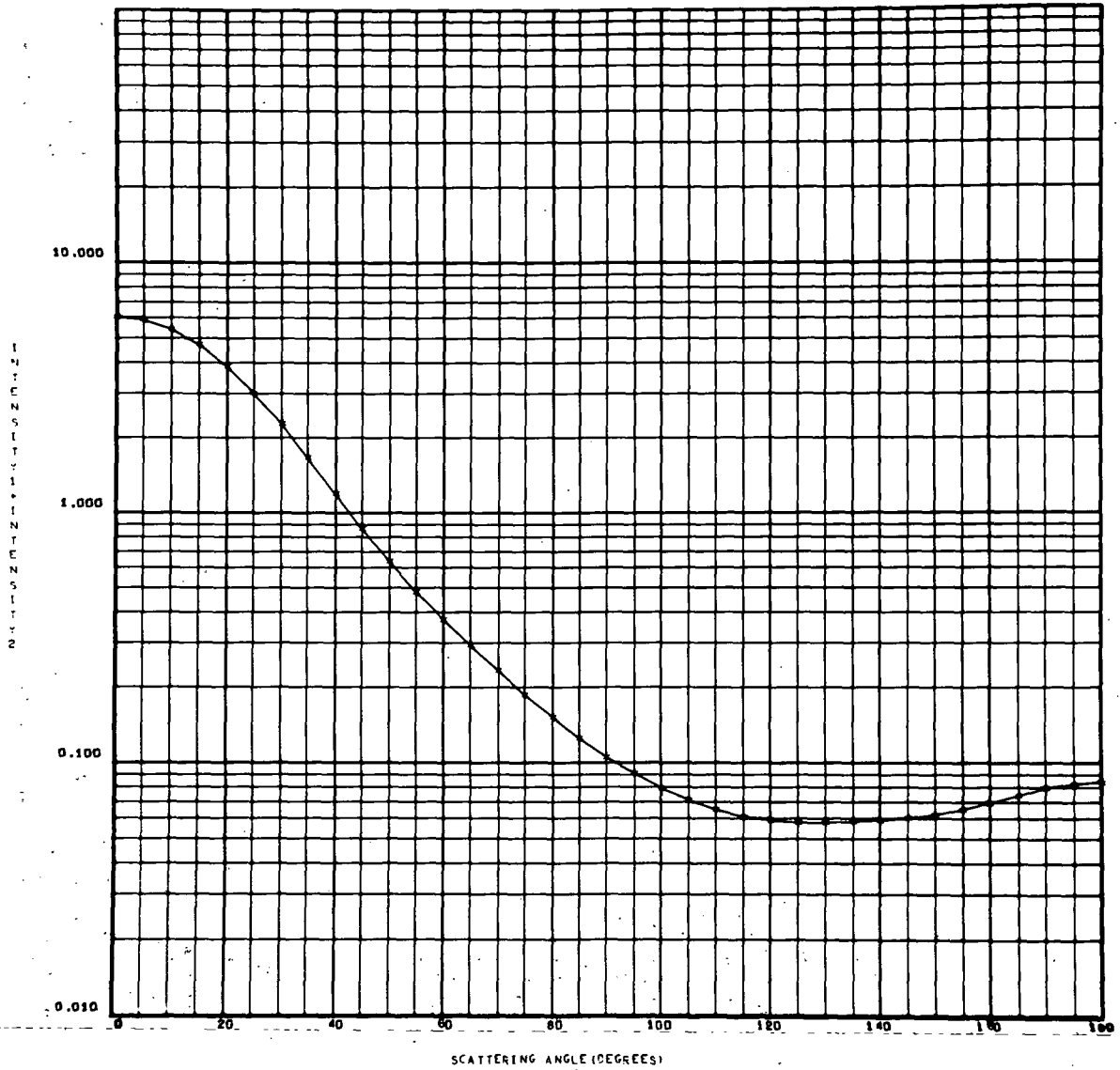


Figure 7. Intensity versus scattering angle  
for water (ice) with  $1 \leq \alpha \leq 5$ .

QUARTZ  
 $m = 1.55 - 0.00i$   
 $1 \leq \alpha \leq 25$

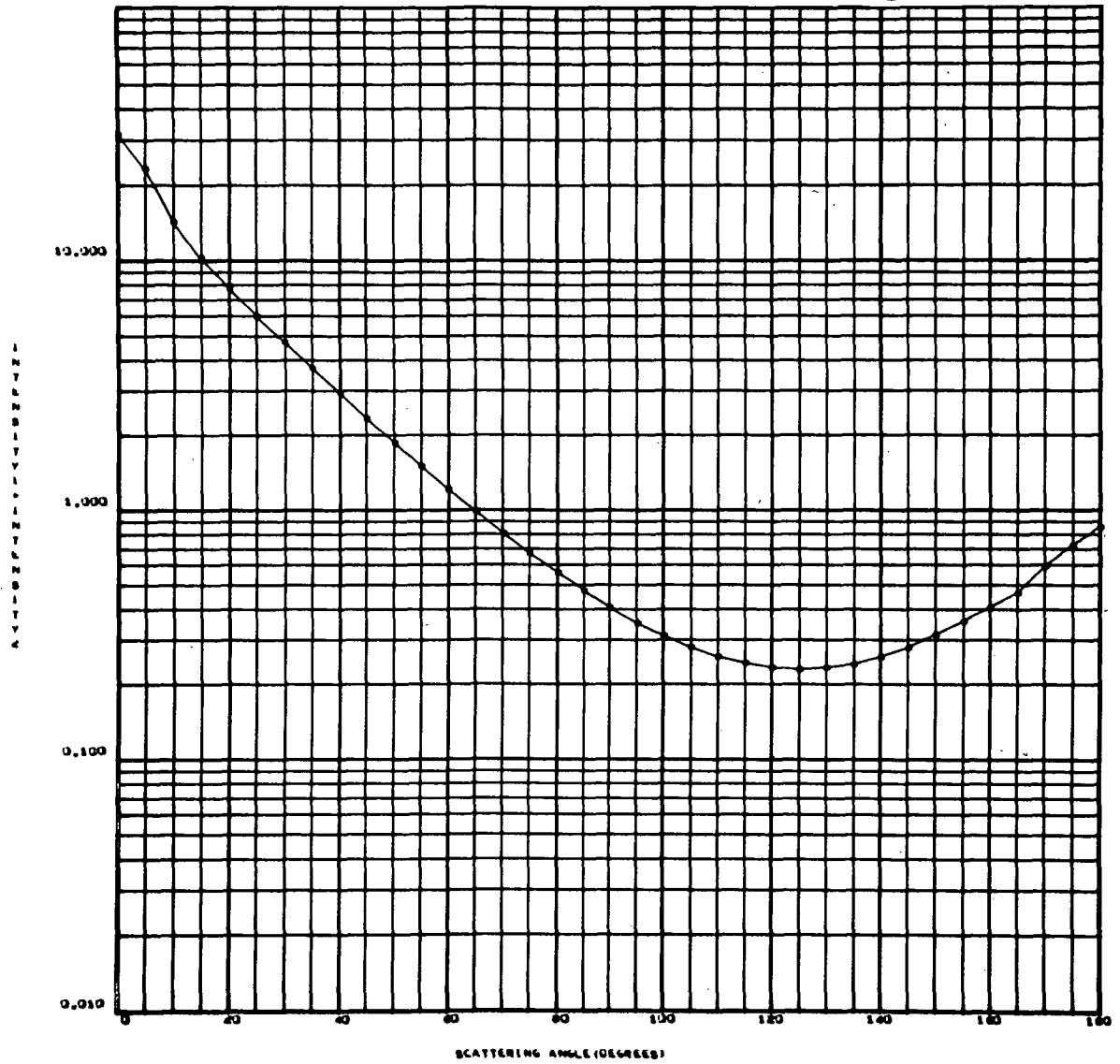


Figure 6. Intensity versus scattering angle  
for quartz with  $1 \leq \alpha \leq 25$ .

QUARTZ  
 $m = 1.55 - 0.00i$   
 $1 \leq \alpha \leq 20$

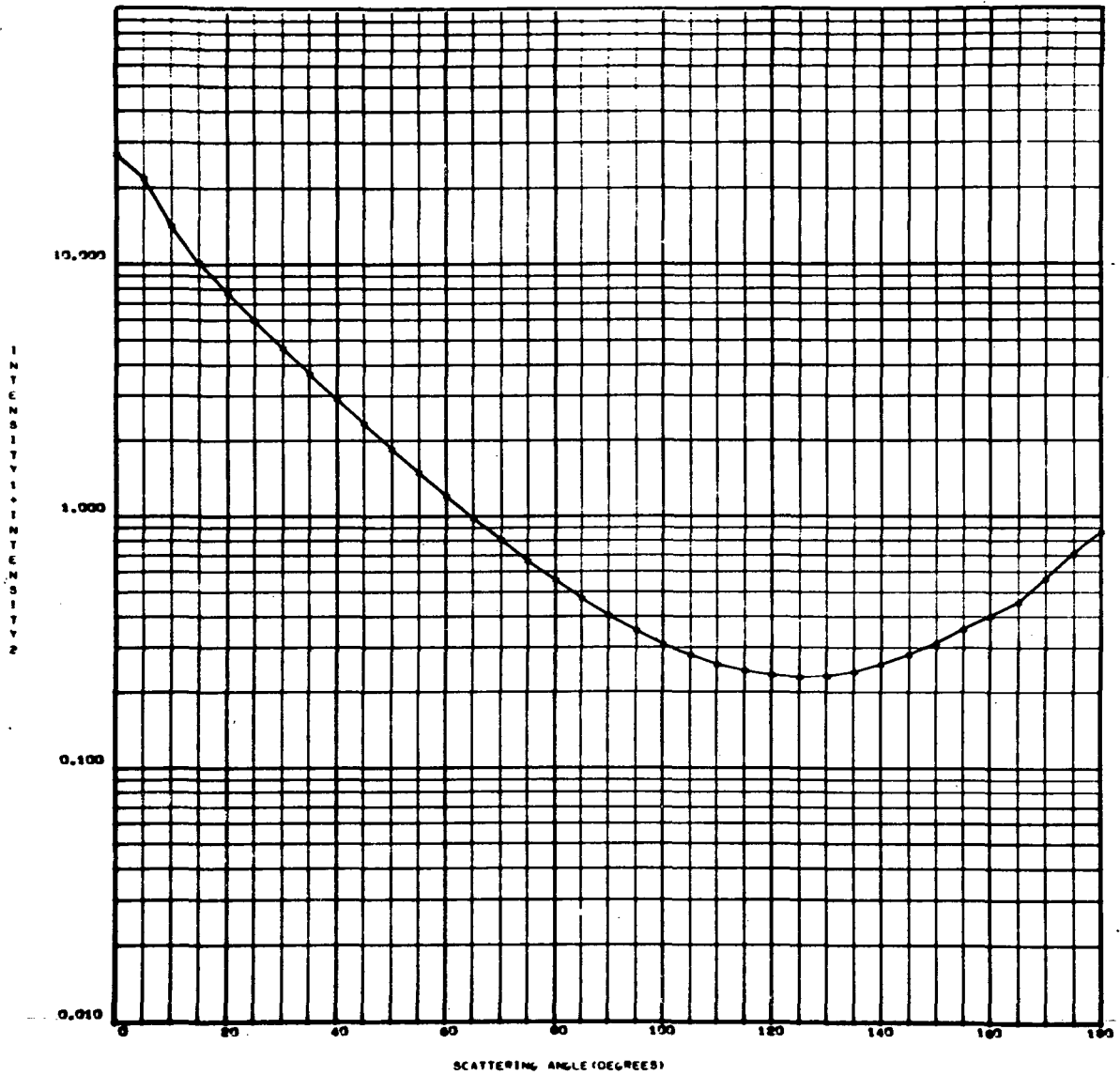


Figure 5. Intensity versus scattering angle  
for quartz with  $1 \leq \alpha \leq 20$ .

QUARTZ

$M = 1.55 - 0.00i$

$1 \leq \alpha \leq 15$

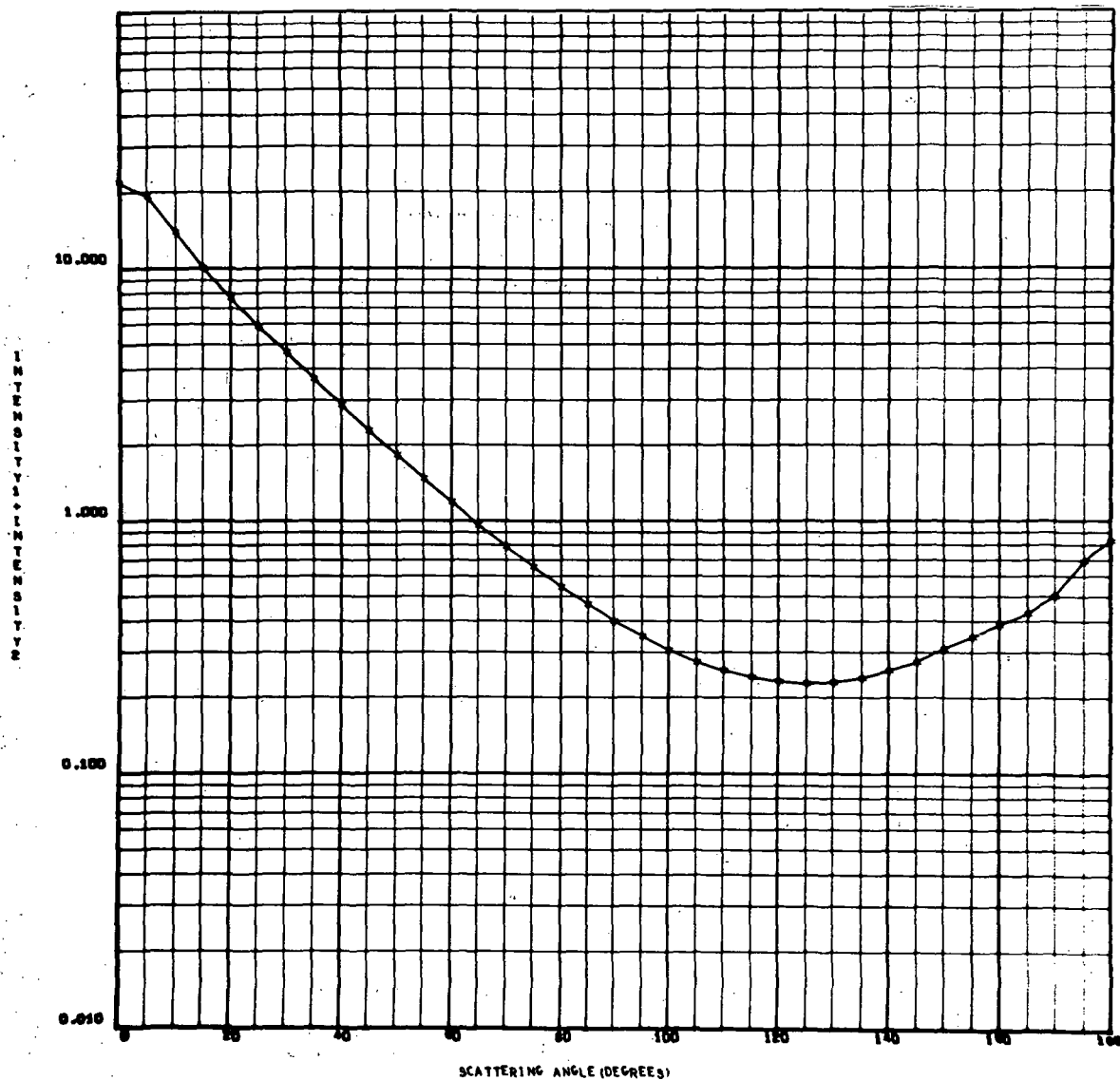


Figure 4. Intensity versus scattering angle  
for quartz with  $1 \leq \alpha \leq 15$ .

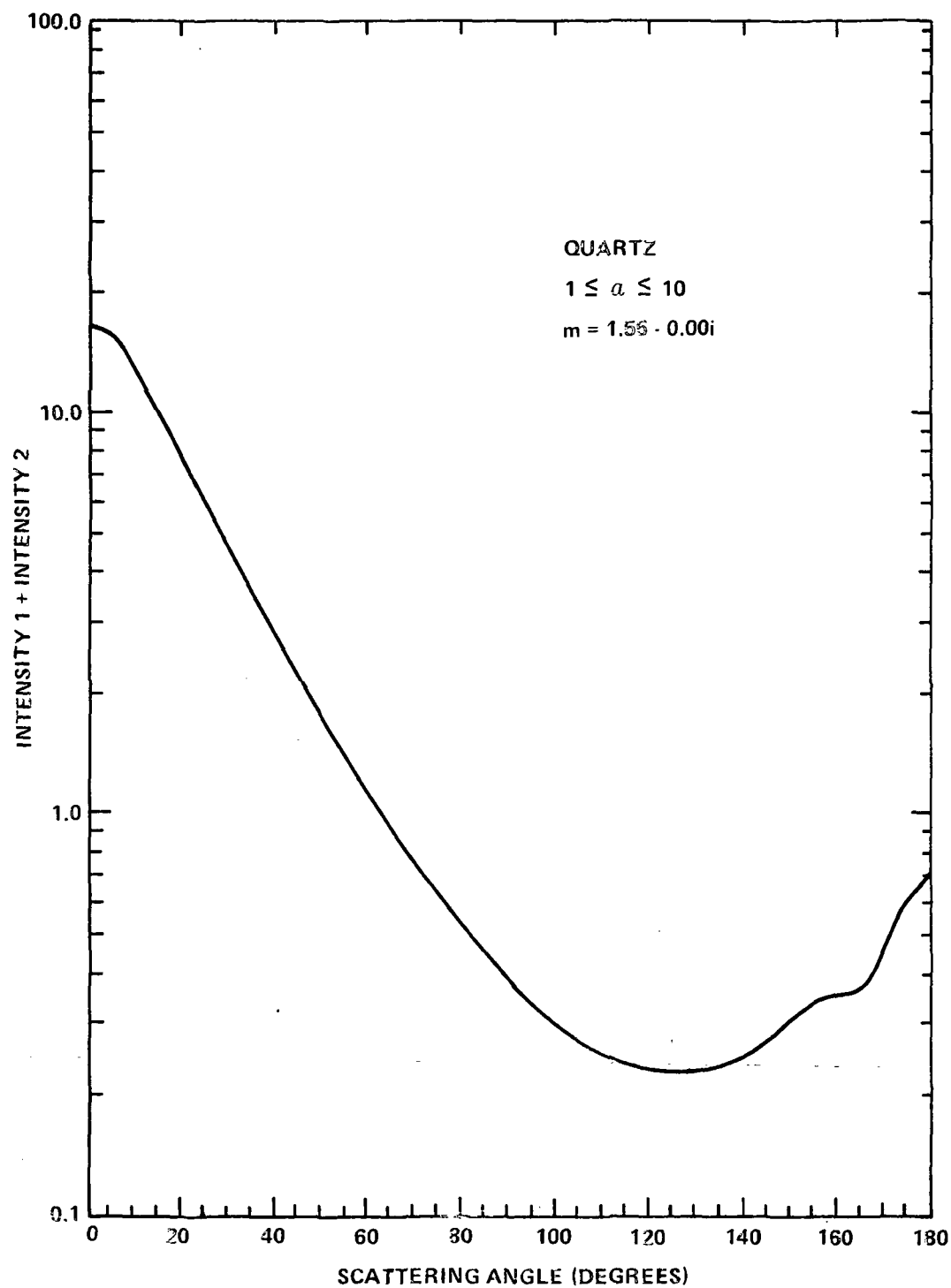


Figure 3. Intensity versus scattering angle  
for quartz with  $1 \leq a \leq 10$ .



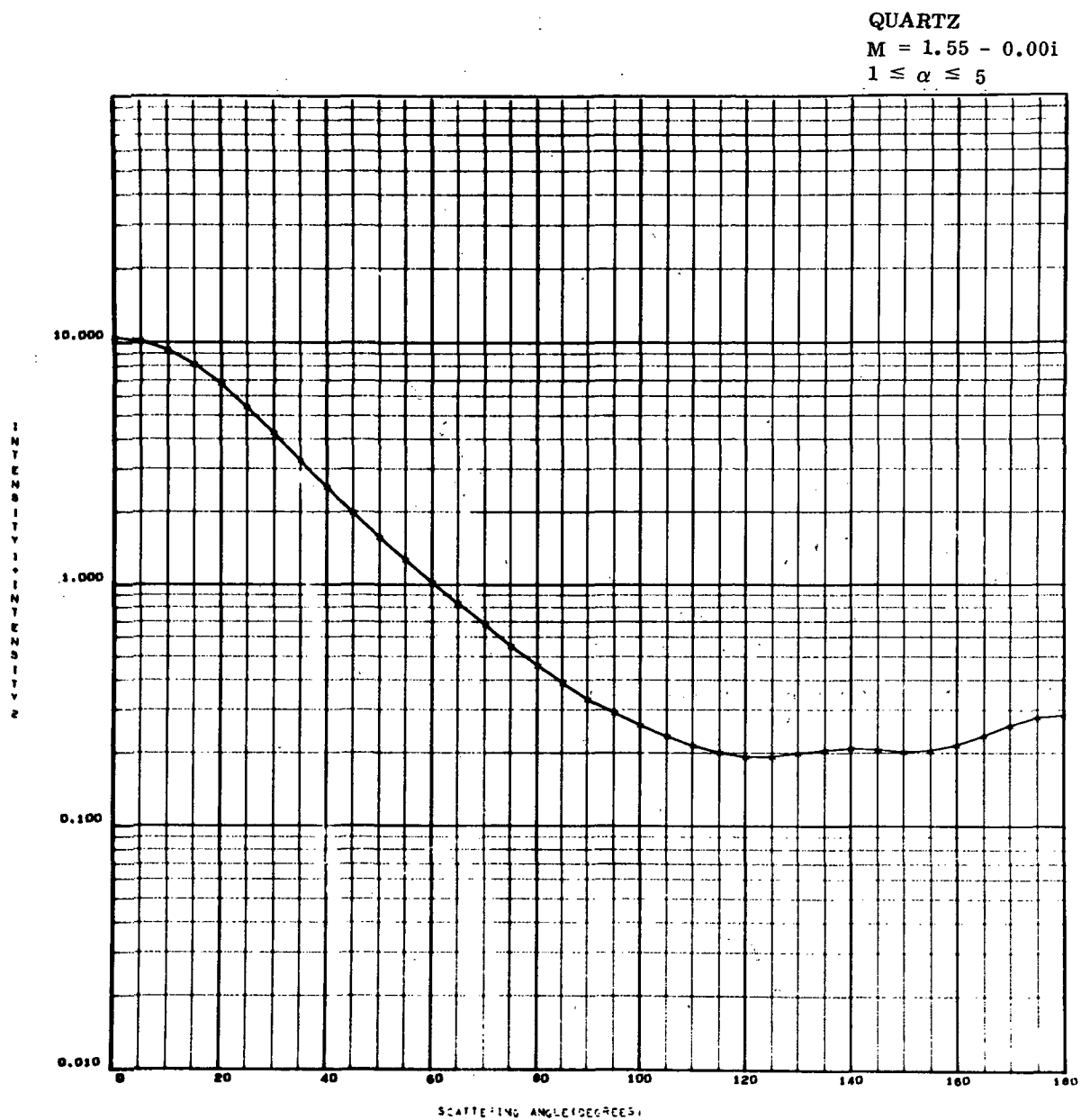


Figure 2. Intensity versus scattering angle  
for quartz with  $1 \leq \alpha \leq 5$ .

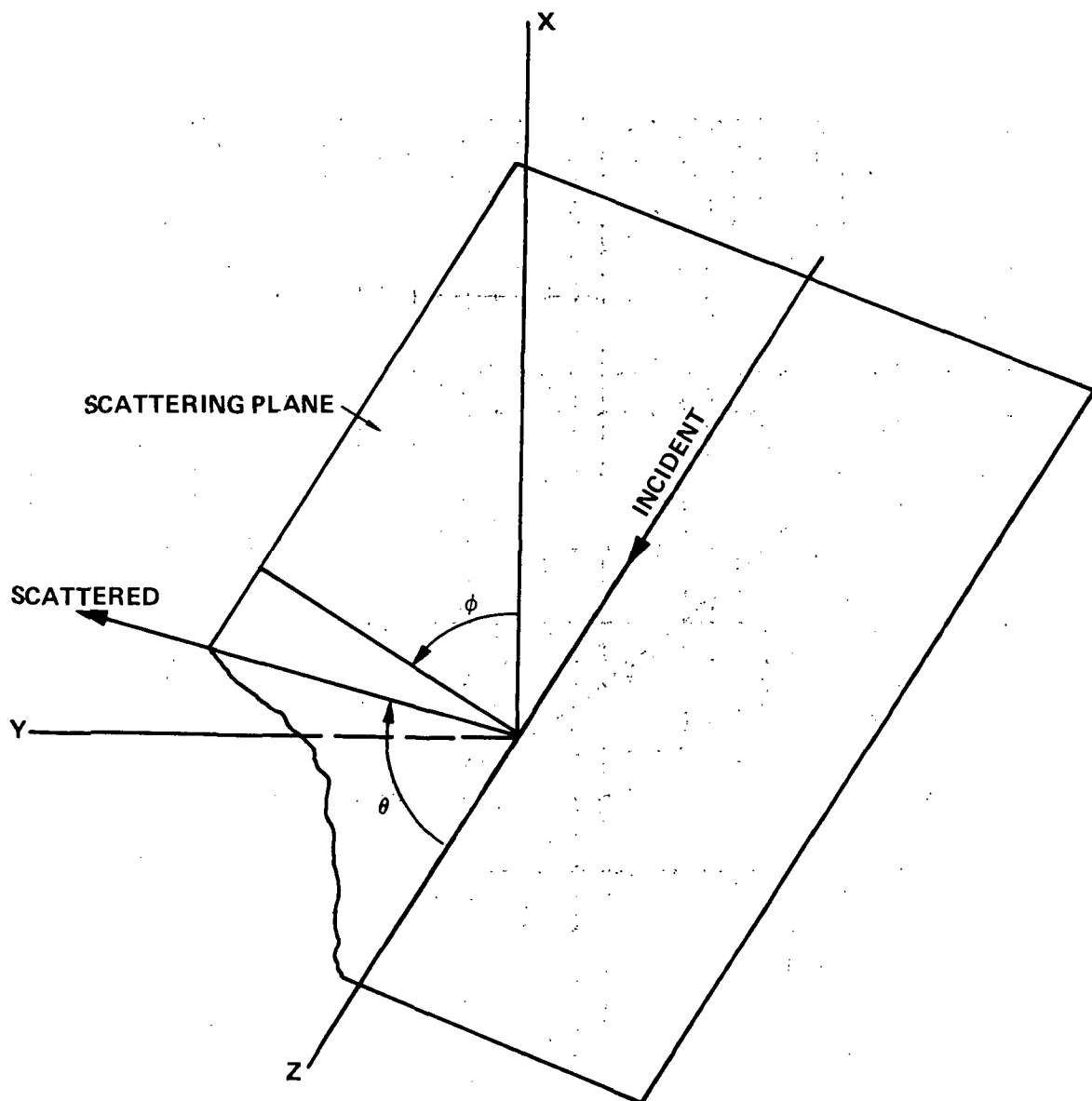


Figure 1. View from back side of coordinate system showing scattering plane.

TABLE 40. INTENSITY AND POLARIZATION FOR ZINC ( $1 \leq \alpha \leq 25$ )

| MATERIALS PRESENT ARE |                   |  | NO OF PARTICLES PER UNIT VOL. = |           | POLARIZATION                 |
|-----------------------|-------------------|--|---------------------------------|-----------|------------------------------|
| ZINC M=               |                   |  | -4.100001                       |           |                              |
| 15.0 ≤ Z5             |                   |  |                                 |           | 4.999680 x 10 <sup>-12</sup> |
| THEIA                 | GAUSSIAN INTEGRAL |  | X12 INTEN                       | INTENSITY |                              |
|                       | X11 INTEN         |  |                                 |           |                              |
| •00                   | 30.484298         |  | 30.484298                       | 30.484298 | •000000                      |
| 5•00                  | 21.507051         |  | 19.940035                       | 20.723543 | •037608                      |
| 10•00                 | 12.284328         |  | 10.544223                       | 11.414276 | •076225                      |
| 15•00                 | 8.584277          |  | 6.835834                        | 7.710055  | •113387                      |
| 20•00                 | 6.578367          |  | 4.832407                        | 5.705387  | •153010                      |
| 25•00                 | 5.321054          |  | 3.587070                        | 4.454062  | •194652                      |
| 30•00                 | 4.459269          |  | 2.753732                        | 3.606500  | •236453                      |
| 35•00                 | 3.829996          |  | 2.176950                        | 3.003473  | •275189                      |
| 40•00                 | 3.350049          |  | 1.773149                        | 2.561619  | •307602                      |
| 45•00                 | 2.972845          |  | 1.489032                        | 2.230938  | •332554                      |
| 50•00                 | 2.669008          |  | 1.290529                        | 1.979769  | •348141                      |
| 55•00                 | 2.419430          |  | 1.155760                        | 1.787595  | •353455                      |
| 60•00                 | 2.211392          |  | 1.067237                        | 1.639314  | •348974                      |
| 65•00                 | 2.035911          |  | 1.010902                        | 1.523406  | •336420                      |
| 70•00                 | 1.866410          |  | .977413                         | 1.431911  | •317407                      |
| 75•00                 | 1.758118          |  | .959248                         | 1.358683  | •293987                      |
| 80•00                 | 1.647429          |  | .949821                         | 1.298625  | •268575                      |
| 85•00                 | 1.551540          |  | .945174                         | 1.248357  | •242866                      |
| 90•00                 | 1.468320          |  | .942340                         | 1.205330  | •218189                      |
| 95•00                 | 1.396071          |  | .938924                         | 1.167498  | •195781                      |
| 100•00                | 1.333435          |  | .934247                         | 1.133941  | •176034                      |
| 105•00                | 1.279340          |  | .927846                         | 1.103593  | •159250                      |
| 110•00                | 1.232886          |  | .919959                         | 1.076422  | •145355                      |
| 115•00                | 1.193345          |  | .911561                         | 1.052453  | •133670                      |
| 120•00                | 1.160098          |  | .903489                         | 1.031793  | •124351                      |
| 125•00                | 1.132608          |  | .897227                         | 1.014918  | •115961                      |
| 130•00                | 1.110409          |  | .893906                         | 1.002158  | •108018                      |
| 135•00                | 1.093061          |  | .894859                         | .993960   | •099703                      |
| 140•00                | 1.080157          |  | .900994                         | .990576   | •090434                      |
| 145•00                | 1.071275          |  | .913025                         | .992150   | •079751                      |
| 150•00                | 1.065982          |  | .931052                         | .998517   | •067565                      |
| 155•00                | 1.063787          |  | .954674                         | 1.009230  | •054057                      |
| 160•00                | 1.064129          |  | .982596                         | 1.023363  | •039836                      |
| 165•00                | 1.066318          |  | 1.012733                        | 1.039526  | •025773                      |
| 170•00                | 1.069486          |  | 1.041594                        | 1.055540  | •013212                      |
| 175•00                | 1.072522          |  | 1.064337                        | 1.068430  | •003830                      |
| 180•00                | 1.073875          |  | 1.073875                        | 1.073875  | •000000                      |

TABLE 39. INTENSITY AND POLARIZATION FOR ZINC ( $1 \leq \alpha \leq 20$ )

| MATERIALS PRESENT ARE<br>ICE H <sub>2</sub> O |           | 1.33000           | -0.100001 | NO OF PARTICLES PER UNIT VOL. = | 4.999376 x 10 <sup>-12</sup> |
|---|-----------|-------------------|-----------|---------------------------------|------------------------------|
| THETA   |           | GAUSSIAN INTEGRAL |           |                                 |                              |
|   |           | X11 INTER         | X12 INTER | INTENSITY                       | POLARIZATION                 |
| 0.00  | 21.262698 | 21.262698         | 21.262698 | 21.262698                       | 0.000000                     |
| 5.00  | 16.210219 | 16.168928         | 16.168928 | 16.168928                       | 0.01273                      |
| 10.00   | 9.094925  | 8.998610          | 8.998610  | 9.046764                        | 0.005323                     |
| 15.00   | 5.598091  | 5.453335          | 5.453335  | 5.525713                        | 0.013098                     |
| 20.00   | 3.727842  | 3.544586          | 3.544586  | 3.636415                        | 0.025178                     |
| 25.00   | 2.599259  | 2.387808          | 2.387808  | 2.492334                        | 0.042400                     |
| 30.00   | 1.868335  | 1.639649          | 1.639649  | 1.753992                        | 0.065190                     |
| 35.00   | 1.379689  | 1.142624          | 1.142624  | 1.261156                        | 0.093987                     |
| 40.00   | 1.040957  | .802918           | .802918   | .921937                         | 0.129077                     |
| 45.00   | .600945   | .567492           | .567492   | .684218                         | 0.170598                     |
| 50.00   | .627112   | .402253           | .402253   | .514683                         | 0.218445                     |
| 55.00   | .498637   | .285276           | .285276   | .371772                         | 0.272199                     |
| 60.00   | .402297   | .202126           | .202126   | .302226                         | 0.331112                     |
| 65.00   | .328760   | .142971           | .142971   | .235865                         | 0.393645                     |
| 70.00   | .271943   | .100966           | .100966   | .186455                         | 0.458444                     |
| 75.00   | .227475   | .071357           | .071357   | .149410                         | 0.522429                     |
| 80.00   | .192290   | .050747           | .050747   | .121319                         | 0.582390                     |
| 85.00   | .164192   | .036676           | .036676   | .100444                         | 0.639563                     |
| 90.00   | .141541   | .027424           | .027424   | .084483                         | 0.675388                     |
| 95.00   | .123164   | .021634           | .021634   | .072399                         | 0.701189                     |
| 100.00  | .108145   | .018371           | .018371   | .063258                         | 0.709580                     |
| 105.00  | .095817   | .016937           | .016937   | .056377                         | 0.699579                     |
| 110.00  | .085050   | .016813           | .016813   | .051231                         | 0.671317                     |
| 115.00  | .077244   | .017628           | .017628   | .047436                         | 0.628375                     |
| 120.00  | .070284   | .019102           | .019102   | .044693                         | 0.572602                     |
| 125.00  | .064518   | .021045           | .021045   | .042782                         | 0.508091                     |
| 130.00  | .059755   | .023304           | .023304   | .041529                         | 0.438452                     |
| 135.00  | .055827   | .025791           | .025791   | .040809                         | 0.368007                     |
| 140.00  | .052609   | .028417           | .028417   | .040313                         | 0.298564                     |
| 145.00  | .049984   | .031127           | .031127   | .040556                         | 0.232478                     |
| 150.00  | .047859   | .033848           | .033848   | .040854                         | 0.171472                     |
| 155.00  | .046141   | .036474           | .036474   | .041308                         | 0.117012                     |
| 160.00  | .044743   | .038826           | .038826   | .041787                         | 0.070665                     |
| 165.00  | .043631   | .041592           | .041592   | .042112                         | 0.036087                     |
| 170.00  | .042860   | .041594           | .041594   | .042222                         | 0.015111                     |
| 175.00  | .042618   | .042249           | .042249   | .042433                         | 0.004344                     |
| 180.00  | .042670   | .042670           | .042670   | .042670                         | 0.000000                     |

TABLE 38. INTENSITY AND POLARIZATION FOR ZINC ( $1 \leq \alpha \leq 15$ )

| MATERIALS PRESENT ARE |                   | 1.41000   |           | -4.100001 |              | NO OF PARTICLES PER UNIT VOL. = |  | 4.98518 x 10 <sup>-12</sup> |  |
|-----------------------|-------------------|-----------|-----------|-----------|--------------|---------------------------------|--|-----------------------------|--|
| ZINC $\alpha =$       |                   |           |           |           |              |                                 |  |                             |  |
| 15 $\alpha \leq 15$   |                   |           |           |           |              |                                 |  |                             |  |
| THETA                 | GAUSSIAN INTEGRAL | ALL INTER | AL2 INTER | INTENSITY | POLARIZATION |                                 |  |                             |  |
| 0.00                  | 19.517700         | 19.517700 | 19.517700 | 19.517700 | 0.000000     |                                 |  |                             |  |
| 5.00                  | 16.942330         | 16.161774 | 10.552055 | 10.552055 | 0.23579      |                                 |  |                             |  |
| 10.00                 | 12.002244         | 10.357800 | 11.100065 | 11.100065 | 0.73540      |                                 |  |                             |  |
| 15.00                 | 6.927722          | 6.733810  | 7.560081  | 7.560081  | 1.11734      |                                 |  |                             |  |
| 20.00                 | 0.496954          | 4.790002  | 5.043470  | 5.043470  | 1.51232      |                                 |  |                             |  |
| 25.00                 | 5.272241          | 3.553222  | 4.712732  | 4.712732  | 1.94700      |                                 |  |                             |  |
| 30.00                 | 4.418630          | 2.734725  | 3.570082  | 3.570082  | 2.35402      |                                 |  |                             |  |
| 35.00                 | 3.798750          | 2.157333  | 2.975145  | 2.975145  | 2.75012      |                                 |  |                             |  |
| 40.00                 | 3.322155          | 1.759403  | 2.540780  | 2.540780  | 3.07334      |                                 |  |                             |  |
| 45.00                 | 2.948620          | 1.472520  | 2.210570  | 2.210570  | 3.33072      |                                 |  |                             |  |
| 50.00                 | 2.646500          | 1.2277505 | 1.902042  | 1.902042  | 3.46030      |                                 |  |                             |  |
| 55.00                 | 2.396401          | 1.142117  | 1.770259  | 1.770259  | 3.54031      |                                 |  |                             |  |
| 60.00                 | 2.191623          | 1.053374  | 1.622501  | 1.622501  | 3.50764      |                                 |  |                             |  |
| 65.00                 | 2.010000          | .998000   | 1.507440  | 1.507440  | 3.37074      |                                 |  |                             |  |
| 70.00                 | 1.868067          | .963573   | 1.415040  | 1.415040  | 3.19720      |                                 |  |                             |  |
| 75.00                 | 1.740206          | .946212   | 1.337349  | 1.337349  | 2.95374      |                                 |  |                             |  |
| 80.00                 | 1.630012          | .930177   | 1.263065  | 1.263065  | 2.70405      |                                 |  |                             |  |
| 85.00                 | 1.534533          | .931620   | 1.233077  | 1.233077  | 2.44474      |                                 |  |                             |  |
| 90.00                 | 1.451570          | .928814   | 1.170195  | 1.170195  | 2.19012      |                                 |  |                             |  |
| 95.00                 | 1.379012          | .924901   | 1.152256  | 1.152256  | 1.97315      |                                 |  |                             |  |
| 100.00                | 1.317214          | .920512   | 1.110863  | 1.110863  | 1.77274      |                                 |  |                             |  |
| 105.00                | 1.263295          | .913814   | 1.060557  | 1.060557  | 1.50523      |                                 |  |                             |  |
| 110.00                | 1.217014          | .905735   | 1.001349  | 1.001349  | 1.19051      |                                 |  |                             |  |
| 115.00                | 1.177655          | .897400   | 1.037550  | 1.037550  | 1.35027      |                                 |  |                             |  |
| 120.00                | 1.144537          | .889194   | 1.010040  | 1.010040  | 1.25574      |                                 |  |                             |  |
| 125.00                | 1.117193          | .882711   | .994952   | .994952   | 1.17274      |                                 |  |                             |  |
| 130.00                | 1.095101          | .879535   | .967310   | .967310   | 1.00877      |                                 |  |                             |  |
| 135.00                | 1.077840          | .868277   | .979062   | .979062   | .871592      |                                 |  |                             |  |
| 140.00                | 1.065042          | .860313   | .975678   | .975678   | .660740      |                                 |  |                             |  |
| 145.00                | 1.056240          | .850420   | .977330   | .977330   | .508724      |                                 |  |                             |  |
| 150.00                | 1.050997          | .916373   | .980035   | .980035   | .334635      |                                 |  |                             |  |
| 155.00                | 1.048867          | .939817   | .991342   | .991342   | .040404      |                                 |  |                             |  |
| 160.00                | 1.049275          | .967778   | 1.000526  | 1.000526  | .026101      |                                 |  |                             |  |
| 165.00                | 1.051491          | .997447   | 1.024744  | 1.024744  | .013374      |                                 |  |                             |  |
| 170.00                | 1.054090          | 1.026770  | 1.040709  | 1.040709  | .003019      |                                 |  |                             |  |
| 175.00                | 1.057563          | 1.049510  | 1.053540  | 1.053540  | .000000      |                                 |  |                             |  |
| 180.00                | 1.058783          | 1.058783  | 1.058783  | 1.058783  | .000000      |                                 |  |                             |  |

TABLE 37. INTENSITY AND POLARIZATION FOR ZINC ( $1 \leq \alpha \leq 10$ )

| MATERIAL'S PRESENT ARE<br>ZINC |                   | 1.41000   | -4.10000 I | NO OF PARTICLES PER UNIT VOL. - 4.985000 x 10 <sup>12</sup> |              |
|--------------------------------|-------------------|-----------|------------|---|--------------|
| $1 \leq \alpha < 10$           |                   |           |            |   |              |
| THETA                          | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN  | INTENSITY   | POLARIZATION |
| 5.00                           | 13.596426         | 13.596426 | 13.596426  | 13.596426   | .000000      |
| 10.00                          | 12.719252         | 12.314306 | 12.516779  | 12.516779   | .016176      |
| 15.00                          | 10.585108         | 9.407516  | 9.996812   | 9.996812  | .058948      |
| 20.00                          | 8.230752          | 6.593956  | 6.593956   | 7.412354  | .110410      |
| 25.00                          | 6.388708          | 4.696080  | 4.696080   | 5.542394  | .152698      |
| 30.00                          | 5.171955          | 3.512291  | 3.512291   | 4.342123  | .191112      |
| 35.00                          | 4.358563          | 2.695660  | 2.695660   | 3.527111  | .235731      |
| 40.00                          | 3.754340          | 2.125919  | 2.125919   | 2.940130  | .276930      |
| 45.00                          | 3.282631          | 1.737321  | 1.737321   | 2.509976  | .307834      |
| 50.00                          | 2.912911          | 1.455315  | 1.455315   | 2.184113  | .333681      |
| 55.00                          | 2.616333          | 1.253696  | 1.253696   | 1.935014  | .352100      |
| 60.00                          | 2.370715          | 1.123605  | 1.123605   | 1.747160  | .356896      |
| 65.00                          | 2.164945          | 1.038141  | 1.038141   | 1.601543  | .351787      |
| 70.00                          | 1.991908          | .979163   | .979163    | 1.485536  | .340869      |
| 75.00                          | 1.844567          | .945235   | .945235    | 1.394901  | .322364      |
| 80.00                          | 1.717563          | .929453   | .929453    | 1.323508  | .297735      |
| 85.00                          | 1.607823          | .919981   | .919981    | 1.263902  | .272111      |
| 90.00                          | 1.513003          | .913473   | .913473    | 1.213238  | .247078      |
| 95.00                          | 1.430711          | .910790   | .910790    | 1.170750  | .222046      |
| 100.00                         | 1.359069          | .908587   | .908587    | 1.133828  | .198655      |
| 105.00                         | 1.296932          | .903262   | .903262    | 1.100097  | .178925      |
| 110.00                         | 1.243391          | .895714   | .895714    | 1.069553  | .162534      |
| 115.00                         | 1.197460          | .887988   | .887988    | 1.042724  | .148396      |
| 120.00                         | 1.158287          | .880038   | .880038    | 1.019162  | .136509      |
| 125.00                         | 1.125322          | .871704   | .871704    | .998513   | .126998      |
| 130.00                         | 1.098148          | .864636   | .864636    | .981392   | .118970      |
| 135.00                         | 1.076284          | .861083   | .861083    | .968683   | .111079      |
| 140.00                         | 1.059205          | .862303   | .862303    | .960754   | .102473      |
| 145.00                         | 1.046474          | .868603   | .868603    | .957538   | .092879      |
| 150.00                         | 1.037741          | .880255   | .880255    | .958998   | .082110      |
| 155.00                         | 1.032624          | .897900   | .897900    | .965262   | .069787      |
| 160.00                         | 1.030615          | .921570   | .921570    | .976092   | .055858      |
| 165.00                         | 1.031085          | .949663   | .949663    | .990374   | .041107      |
| 170.00                         | 1.033292          | .979672   | .979672    | 1.006482  | .026638      |
| 175.00                         | 1.036277          | 1.008597  | 1.008597   | 1.022437  | .013536      |
| 180.00                         | 1.038835          | 1.031100  | 1.031100   | 1.034967  | .003737      |
|                                | 1.039845          | 1.039845  | 1.039845   | 1.039845  | .000000      |

TABLE 36. INTENSITY AND POLARIZATION FOR ZINC ( $1 \leq \alpha \leq 5$ )

| MATERIALS PRESENT ARE<br>ZINC $M=$<br>$1 \leq K \leq 5$ |                   | 1.41000   | -4.100001 | NO OF PARTICLES PER UNIT VOL. = $4.960000 \times 10^{12}$ |              |
|---|-------------------|-----------|-----------|---|--------------|
| THETA   | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY   | POLARIZATION |
| .00   | 7.054593          | 7.054593  | 7.054593  | 7.054593  | .000000      |
| 5.00  | 6.928898          | 6.928898  | 6.798343  | 6.863621  | .009511      |
| 10.00   | 6.572350          | 6.572350  | 6.098110  | 6.335230  | .037429      |
| 15.00   | 6.040659          | 6.040659  | 5.130107  | 5.585383  | .081512      |
| 20.00   | 5.409414          | 5.409414  | 4.106354  | 4.757883  | .136937      |
| 25.00   | 4.755196          | 4.755196  | 3.198230  | 3.976713  | .195760      |
| 30.00   | 4.139655          | 4.139655  | 2.491712  | 3.315683  | .248507      |
| 35.00   | 3.600934          | 3.600934  | 1.988416  | 2.794675  | .288498      |
| 40.00   | 3.153277          | 3.153277  | 1.640201  | 2.396739  | .315653      |
| 45.00   | 2.792631          | 2.792631  | 1.390937  | 2.091784  | .335047      |
| 50.00   | 2.504679          | 2.504679  | 1.203056  | 1.853867  | .351056      |
| 55.00   | 2.272165          | 2.272165  | 1.061779  | 1.666972  | .363049      |
| 60.00   | 2.079779          | 2.079779  | .964476   | 1.522127  | .366363      |
| 65.00   | 1.916300          | 1.916300  | .907993   | 1.412147  | .357312      |
| 70.00   | 1.774671          | 1.774671  | .882811   | 1.328741  | .335004      |
| 75.00   | 1.650950          | 1.650950  | .875140   | 1.263045  | .307119      |
| 80.00   | 1.542977          | 1.542977  | .872585   | 1.207781  | .277531      |
| 85.00   | 1.449275          | 1.449275  | .868257   | 1.158766  | .250705      |
| 90.00   | 1.368416          | 1.368416  | .861053   | 1.114734  | .227572      |
| 95.00   | 1.298025          | 1.298025  | .852980   | 1.075903  | .207196      |
| 100.00  | 1.238882          | 1.238882  | .846029   | 1.042456  | .188427      |
| 105.00  | 1.187129          | 1.187129  | .840523   | 1.013826  | .170939      |
| 110.00  | 1.142431          | 1.142431  | .835372   | .988902   | .155252      |
| 115.00  | 1.104028          | 1.104028  | .829375   | .966702   | .142057      |
| 120.00  | 1.071462          | 1.071462  | .822347   | .946905   | .131542      |
| 125.00  | 1.044452          | 1.044452  | .815383   | .929917   | .123166      |
| 130.00  | 1.022764          | 1.022764  | .810345   | .916555   | .115879      |
| 135.00  | 1.006122          | 1.006122  | .809139   | .907630   | .108515      |
| 140.00  | .994155           | .994155   | .813289   | .903722   | .100068      |
| 145.00  | .986384           | .986384   | .823894   | .905139   | .089759      |
| 150.00  | .982206           | .982206   | .841631   | .911918   | .077076      |
| 155.00  | .980899           | .980899   | .866437   | .923668   | .061760      |
| 160.00  | .981630           | .981630   | .898868   | .939249   | .045122      |
| 165.00  | .983502           | .983502   | .929540   | .956521   | .028207      |
| 170.00  | .985628           | .985628   | .959280   | .972454   | .013547      |
| 175.00  | .987251           | .987251   | .980266   | .983758   | .003550      |
| 180.00  | .987853           | .987853   | .987853   | .987853   | .000000      |

TABLE 35. INTENSITY AND POLARIZATION FOR IRON ( $1 \leq \alpha \leq 25$ )

| MATERIALS PRESENT ARE<br>IRON. $M =$ |   | 1.27000   | -1.37000  | NO. OF PARTICLES PER UNIT VOL. = |              | 4.999680 x 10 <sup>-12</sup> |
|--------------------------------------|---|-----------|-----------|----------------------------------|--------------|------------------------------|
| THETA                                | GAUSSIAN INTEGRAL<br>$15 \leq \alpha \leq 25$ |           |           |                                  |              |                              |
|                                      |   | X11 INTEN | X12 INTEN | INTENSITY                        | POLARIZATION |                              |
| .00                                  | 28.635384                                     | 28.635384 | 28.635384 | 28.635384                        | .000000      |                              |
| 5.00                                 | 20.131470                                     | 19.022488 | 19.022488 | 19.576978                        | .028324      |                              |
| 10.00                                | 11.288367                                     | 9.801907  | 9.801907  | 10.545137                        | .070481      |                              |
| 15.00                                | 7.647313                                      | 6.084326  | 6.084326  | 6.865820                         | .113824      |                              |
| 20.00                                | 5.645808                                      | 4.065064  | 4.065064  | 4.855436                         | .162781      |                              |
| 25.00                                | 4.383544                                      | 2.813689  | 2.813689  | 3.598617                         | .218119      |                              |
| 30.00                                | 3.518032                                      | 1.983514  | 1.983514  | 2.750773                         | .278925      |                              |
| 35.00                                | 2.888969                                      | 1.411409  | 1.411409  | 2.150169                         | .343568      |                              |
| 40.00                                | 2.413332                                      | 1.009283  | 1.009283  | 1.711307                         | .410227      |                              |
| 45.00                                | 2.043714                                      | .725062   | .725062   | 1.384388                         | .476258      |                              |
| 50.00                                | 1.750196                                      | .525474   | .525474   | 1.137335                         | .538181      |                              |
| 55.00                                | 1.513034                                      | .387670   | .387670   | .950352                          | .592078      |                              |
| 60.00                                | 1.318823                                      | .295179   | .295179   | .807031                          | .634240      |                              |
| 65.00                                | 1.158248                                      | .235998   | .235998   | .697073                          | .661587      |                              |
| 70.00                                | 1.024146                                      | .200769   | .200769   | .612458                          | .672191      |                              |
| 75.00                                | .911400                                       | .182834   | .182834   | .547117                          | .685824      |                              |
| 80.00                                | .816062                                       | .176743   | .176743   | .496403                          | .643952      |                              |
| 85.00                                | .735051                                       | .178474   | .178474   | .456763                          | .609264      |                              |
| 90.00                                | .665956                                       | .184996   | .184996   | .425476                          | .585203      |                              |
| 95.00                                | .606851                                       | .194073   | .194073   | .400462                          | .515378      |                              |
| 100.00                               | .556179                                       | .204151   | .204151   | .380165                          | .462993      |                              |
| 105.00                               | .512679                                       | .214191   | .214191   | .363435                          | .410649      |                              |
| 110.00                               | .475314                                       | .223563   | .223563   | .349439                          | .360222      |                              |
| 115.00                               | .443227                                       | .231972   | .231972   | .337600                          | .312678      |                              |
| 120.00                               | .415707                                       | .239349   | .239349   | .327528                          | .289227      |                              |
| 125.00                               | .392160                                       | .245796   | .245796   | .318978                          | .229425      |                              |
| 130.00                               | .372087                                       | .251518   | .251518   | .311803                          | .193341      |                              |
| 135.00                               | .355069                                       | .256765   | .256765   | .305917                          | .160671      |                              |
| 140.00                               | .340752                                       | .261786   | .261786   | .301269                          | .131055      |                              |
| 145.00                               | .328833                                       | .266784   | .266784   | .297808                          | .104177      |                              |
| 150.00                               | .319056                                       | .271881   | .271881   | .295468                          | .079832      |                              |
| 155.00                               | .311200                                       | .277081   | .277081   | .294141                          | .057998      |                              |
| 160.00                               | .305074                                       | .282250   | .282250   | .293662                          | .038861      |                              |
| 165.00                               | .300513                                       | .287095   | .287095   | .293804                          | .022836      |                              |
| 170.00                               | .297375                                       | .291173   | .291173   | .294274                          | .010539      |                              |
| 175.00                               | .295546                                       | .293951   | .293951   | .294749                          | .002705      |                              |
| 180.00                               | .294946                                       | .294946   | .294946   | .294946                          | .000000      |                              |



TABLE 34. INTENSITY AND POLARIZATION FOR IRON ( $1 \leq \alpha \leq 20$ )

| MATERIALS PRESENT ARE   |                   | 1.27000   | -1.370001 | NO OF PARTICLES PER UNIT VOL. = |              | 4.999375 x 10 <sup>12</sup> |
|-------------------------|-------------------|-----------|-----------|---------------------------------|--------------|-----------------------------|
| IRON M =                |                   |           |           |                                 |              |                             |
| $1 \leq \alpha \leq 20$ |                   |           |           |                                 |              |                             |
| THETA                   | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY                       | POLARIZATION |                             |
| •00                     | 23.637113         | 23.637113 | 23.637113 | 23.637113                       | •000000      |                             |
| 5.00                    | 18.545305         | 17.674267 | 17.674267 | 18.109786                       | •024049      |                             |
| 10.00                   | 11.248442         | 9.766782  | 9.766782  | 10.507612                       | •070504      |                             |
| 15.00                   | 7.599506          | 6.068802  | 6.068802  | 6.833154                        | •112152      |                             |
| 20.00                   | 5.621405          | 4.050573  | 4.050573  | 4.835489                        | •162411      |                             |
| 25.00                   | 4.371039          | 2.809907  | 2.809907  | 3.520473                        | •217399      |                             |
| 30.00                   | 3.506968          | 1.980745  | 1.980745  | 2.743857                        | •278116      |                             |
| 35.00                   | 2.880767          | 1.409488  | 1.409488  | 2.145127                        | •342935      |                             |
| 40.00                   | 2.406159          | 1.007982  | 1.007982  | 1.707075                        | •409527      |                             |
| 45.00                   | 2.037701          | .723832   | .723832   | 1.360766                        | •475775      |                             |
| 50.00                   | 1.744721          | .524581   | .524581   | 1.134651                        | •537672      |                             |
| 55.00                   | 1.508091          | .386736   | .386736   | .947414                         | •571798      |                             |
| 60.00                   | 1.314363          | .274238   | .274238   | .804300                         | •634169      |                             |
| 65.00                   | 1.154025          | .234985   | .234985   | .694505                         | •681652      |                             |
| 70.00                   | 1.020211          | .197778   | .197778   | .609995                         | •672491      |                             |
| 75.00                   | .907690           | .181809   | .181809   | .544749                         | •666251      |                             |
| 80.00                   | .812557           | .175636   | .175636   | .494096                         | •644532      |                             |
| 85.00                   | .731719           | .177316   | .177316   | .454519                         | •609876      |                             |
| 90.00                   | .662786           | .183750   | .183750   | .423268                         | •565878      |                             |
| 95.00                   | .603818           | .192785   | .192785   | .398291                         | •516019      |                             |
| 100.00                  | .553275           | .202763   | .202763   | .378019                         | •463616      |                             |
| 105.00                  | .509888           | .212734   | .212734   | .361311                         | •411217      |                             |
| 110.00                  | .472627           | .222033   | .222033   | .347330                         | •360744      |                             |
| 115.00                  | .440632           | .230376   | .230376   | .335504                         | •313344      |                             |
| 120.00                  | .413197           | .237834   | .237834   | .325440                         | •269653      |                             |
| 125.00                  | .389725           | .244074   | .244074   | .316899                         | •229806      |                             |
| 130.00                  | .369719           | .249736   | .249736   | .309728                         | •193691      |                             |
| 135.00                  | .352761           | .254932   | .254932   | .303347                         | •160984      |                             |
| 140.00                  | .338496           | .259904   | .259904   | .299200                         | •104421      |                             |
| 145.00                  | .326623           | .264860   | .264860   | .295742                         | •080036      |                             |
| 150.00                  | .316885           | .269320   | .269320   | .293403                         | •058159      |                             |
| 155.00                  | .309062           | .273068   | .273068   | .292075                         | •038976      |                             |
| 160.00                  | .302963           | .280232   | .280232   | .291597                         | •022908      |                             |
| 165.00                  | .298422           | .285056   | .285056   | .291739                         | •010574      |                             |
| 170.00                  | .295299           | .289119   | .289119   | .292209                         | •002715      |                             |
| 175.00                  | .293479           | .291890   | .291890   | .292684                         | •000000      |                             |
| 180.00                  | .292882           | .292882   | .292882   | .292882                         | •000000      |                             |

TABLE 33. INTENSITY AND POLARIZATION FOR IRON ( $1 \leq \alpha \leq 15$ )

| MATERIALS PRESENT ARE |                   |           |  | NO OF PARTICLES PER UNIT VOL.= |           | POLARIZATION |
|-----------------------|-------------------|-----------|--|--------------------------------|-----------|--------------|
| IRON $m = 15$         |                   |           |  | 4.988518 x 10 <sup>-12</sup>   |           |              |
| 15 $\alpha \leq 15$   |                   |           |  |                                |           |              |
| THETA                 | GAUSSIAN INTEGRAL |           |  | A12 INTEG                      | INTENSITY |              |
|                       | A11 INTEG         |           |  |                                |           |              |
| 0.00                  | 10.395850         | 18.395850 |  | 10.395850                      |           | 0.000000     |
| 5.00                  | 15.077594         | 15.260641 |  | 15.077594                      |           | 0.019003     |
| 10.00                 | 11.037307         | 9.664391  |  | 10.360649                      |           | 0.052900     |
| 15.00                 | 7.510104          | 5.993407  |  | 6.751796                       |           | 0.123120     |
| 20.00                 | 5.577625          | 4.039647  |  | 4.000036                       |           | 0.159104     |
| 25.00                 | 4.344725          | 2.797450  |  | 3.570866                       |           | 0.210100     |
| 30.00                 | 3.406764          | 1.976291  |  | 2.731387                       |           | 0.270452     |
| 35.00                 | 2.805954          | 1.400002  |  | 2.135978                       |           | 0.341752     |
| 40.00                 | 2.393215          | 1.005536  |  | 1.699375                       |           | 0.408291     |
| 45.00                 | 2.027029          | 0.722070  |  | 1.374503                       |           | 0.474071     |
| 50.00                 | 1.735162          | 0.522891  |  | 1.127027                       |           | 0.530005     |
| 55.00                 | 1.499531          | 0.385310  |  | 0.942424                       |           | 0.571142     |
| 60.00                 | 1.306607          | 0.292700  |  | 0.799658                       |           | 0.633458     |
| 65.00                 | 1.146811          | 0.233522  |  | 0.691666                       |           | 0.601675     |
| 70.00                 | 1.013548          | 0.198150  |  | 0.605853                       |           | 0.729270     |
| 75.00                 | 0.901423          | 0.180154  |  | 0.540789                       |           | 0.666008     |
| 80.00                 | 0.806654          | 0.173834  |  | 0.490246                       |           | 0.645405     |
| 85.00                 | 0.726143          | 0.175403  |  | 0.450773                       |           | 0.610003     |
| 90.00                 | 0.657470          | 0.161736  |  | 0.419603                       |           | 0.560005     |
| 95.00                 | 0.598759          | 0.190507  |  | 0.394673                       |           | 0.517102     |
| 100.00                | 0.548430          | 0.200497  |  | 0.374403                       |           | 0.464375     |
| 105.00                | 0.505239          | 0.210320  |  | 0.357779                       |           | 0.412152     |
| 110.00                | 0.468156          | 0.219504  |  | 0.343030                       |           | 0.361591     |
| 115.00                | 0.436310          | 0.227740  |  | 0.332029                       |           | 0.314094     |
| 120.00                | 0.409024          | 0.234929  |  | 0.321977                       |           | 0.270354     |
| 125.00                | 0.385661          | 0.241210  |  | 0.313449                       |           | 0.230440     |
| 130.00                | 0.365787          | 0.246791  |  | 0.306289                       |           | 0.194255     |
| 135.00                | 0.348930          | 0.251884  |  | 0.300410                       |           | 0.161513     |
| 140.00                | 0.334754          | 0.256786  |  | 0.295770                       |           | 0.131005     |
| 145.00                | 0.322957          | 0.261674  |  | 0.292315                       |           | 0.104024     |
| 150.00                | 0.313204          | 0.266607  |  | 0.289975                       |           | 0.080381     |
| 155.00                | 0.305510          | 0.271703  |  | 0.288650                       |           | 0.058432     |
| 160.00                | 0.299461          | 0.276806  |  | 0.288173                       |           | 0.039109     |
| 165.00                | 0.294954          | 0.281675  |  | 0.288315                       |           | 0.023029     |
| 170.00                | 0.291856          | 0.285713  |  | 0.288784                       |           | 0.010035     |
| 175.00                | 0.290051          | 0.288470  |  | 0.289261                       |           | 0.002732     |
| 180.00                | 0.289459          | 0.289459  |  | 0.289459                       |           | 0.000000     |

TABLE 32. INTENSITY AND POLARIZATION FOR IRON ( $1 \leq \alpha \leq 10$ )

| MATERIALS PRESENT AND<br>IRON $\alpha \leq$ |                   | 1.270000                | -1.170000 | NO OF PARTICLES PER UNIT VOL. = | 4.995000 x 10 <sup>-12</sup> |
|---|-------------------|-------------------------|-----------|---------------------------------|------------------------------|
|   |                   | $I \leq \alpha \leq 10$ |           |                                 |                              |
| THETA                                       | GAUSSIAN INTEGRAL |                         |           |                                 |                              |
|   | XY1 INTEN         | XY2 INTEN               | INTENSITY | POLARIZATION                    |                              |
| 0.00  | 12.764624         | 12.764624               | 12.764624 | .000000                         |                              |
| 5.00  | 11.476299         | 11.561515               | 11.719397 | .013431                         |                              |
| 10.00                                       | 9.715091          | 8.759547                | 9.244117  | .051319                         |                              |
| 15.00                                       | 7.541552          | 5.950337                | 6.546295  | .104513                         |                              |
| 20.00                                       | 5.465577          | 3.977593                | 4.732085  | .159442                         |                              |
| 25.00                                       | 3.260395          | 2.166367                | 3.513925  | .212574                         |                              |
| 30.00                                       | 2.441145          | 1.966599                | 2.713317  | .272527                         |                              |
| 35.00                                       | 2.032331          | 1.337973                | 2.115377  | .379185                         |                              |
| 40.00                                       | 2.364496          | .009799                 | 1.681899  | .405850                         |                              |
| 45.00                                       | 2.002157          | .719157                 | 1.350610  | .471514                         |                              |
| 50.00                                       | 1.715205          | .519513                 | 1.117411  | .536925                         |                              |
| 55.00                                       | 1.431339          | .332041                 | .931340   | .590015                         |                              |
| 60.00                                       | 1.299992          | .291262                 | .796127   | .672639                         |                              |
| 65.00                                       | 1.131341          | .230591                 | .661256   | .661525                         |                              |
| 70.00                                       | .939939           | .194973                 | .607456   | .673667                         |                              |
| 75.00                                       | .838674           | .176940                 | .522927   | .667347                         |                              |
| 80.00                                       | .794646           | .171511                 | .482579   | .646566                         |                              |
| 85.00                                       | .714934           | .171503                 | .443243   | .612951                         |                              |
| 90.00                                       | .646957           | .177729                 | .412297   | .568924                         |                              |
| 95.00                                       | .544821           | .136473                 | .347550   | .516823                         |                              |
| 100.00                                      | .539747           | .106074                 | .367391   | .466416                         |                              |
| 105.00                                      | .495931           | .205543                 | .350779   | .414010                         |                              |
| 110.00                                      | .459279           | .214544                 | .336911   | .363204                         |                              |
| 115.00                                      | .427757           | .222535                 | .325171   | .315442                         |                              |
| 120.00                                      | .400747           | .229527                 | .315137   | .271652                         |                              |
| 125.00                                      | .377567           | .235563                 | .316613   | .231731                         |                              |
| 130.00                                      | .354011           | .241067                 | .299445   | .195420                         |                              |
| 135.00                                      | .341353           | .245321                 | .293577   | .162501                         |                              |
| 140.00                                      | .327349           | .250546                 | .289097   | .132705                         |                              |
| 145.00                                      | .315706           | .255351                 | .285533   | .105671                         |                              |
| 150.00                                      | .304163           | .260229                 | .283199   | .081111                         |                              |
| 155.00                                      | .295114           | .265253                 | .281345   | .058995                         |                              |
| 160.00                                      | .292545           | .270297                 | .281418   | .039541                         |                              |
| 165.00                                      | .289101           | .275012                 | .281557   | .023243                         |                              |
| 170.00                                      | .285044           | .278992                 | .282018   | .011729                         |                              |
| 175.00                                      | .282251           | .281705                 | .282463   | .002754                         |                              |
| 180.00                                      | .282076           | .282676                 | .282676   | .000000                         |                              |

TABLE 31. INTENSITY AND POLARIZATION FOR IRON ( $1 \leq \alpha \leq 5$ )

| MATERIALS PRESENT ARE<br>IRON, $M =$<br>$1 \leq \alpha \leq 5$ |                   | 1.27000   | -1.37000  | NO OF PARTICLES PER UNIT VOL. = $4.960000 \times 10^{-12}$ |              |
|--|-------------------|-----------|-----------|--|--------------|
| THETA  | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY  | POLARIZATION |
| 0.00   | 6.394307          | 6.394307  | 6.394307  | 6.394307   | .000000      |
| 5.00   | 6.256935          | 6.159275  | 6.208105  | 6.208105   | .007866      |
| 10.00  | 5.868218          | 5.510780  | 5.689499  | 5.689499   | .031412      |
| 15.00  | 5.291536          | 4.596357  | 4.943947  | 4.943947   | .070306      |
| 20.00  | 4.612491          | 3.599230  | 4.105861  | 4.105861   | .123392      |
| 25.00  | 3.916973          | 2.677543  | 3.297258  | 3.297258   | .187949      |
| 30.00  | 3.272720          | 1.925027  | 2.596874  | 2.596874   | .259284      |
| 35.00  | 2.719627          | 1.365110  | 2.042368  | 2.042368   | .331005      |
| 40.00  | 2.269917          | .971874   | 1.620895  | 1.620895   | .400409      |
| 45.00  | 1.915481          | .700430   | 1.307956  | 1.307956   | .464485      |
| 50.00  | 1.637928          | .510410   | 1.074169  | 1.074169   | .524033      |
| 55.00  | 1.417298          | .375530   | .896399   | .896399  | .581102      |
| 60.00  | 1.237277          | .281556   | .759416   | .759416  | .629247      |
| 65.00  | 1.086813          | .220346   | .653580   | .653580  | .662863      |
| 70.00  | .959301           | .184748   | .572025   | .572025  | .677028      |
| 75.00  | .850871           | .167389   | .501130   | .501130  | .671226      |
| 80.00  | .758864           | .161562   | .460213   | .460213  | .648941      |
| 85.00  | .680975           | .162386   | .421680   | .421680  | .614908      |
| 90.00  | .614986           | .167031   | .391008   | .391008  | .572820      |
| 95.00  | .558844           | .174062   | .366453   | .366453  | .525009      |
| 100.00   | .510805           | .182570   | .346687   | .346687  | .473386      |
| 105.00   | .469532           | .191667   | .330585   | .330585  | .420218      |
| 110.00   | .433920           | .200448   | .317184   | .317184  | .368038      |
| 115.00   | .403298           | .208218   | .305758   | .305758  | .319510      |
| 120.00   | .377041           | .214687   | .295864   | .295864  | .274374      |
| 125.00   | .354641           | .219975   | .287308   | .287308  | .234358      |
| 130.00   | .335642           | .224466   | .280054   | .280054  | .198490      |
| 135.00   | .319629           | .228601   | .274115   | .274115  | .166040      |
| 140.00   | .306229           | .232735   | .269482   | .269482  | .136363      |
| 145.00   | .295119           | .237080   | .266100   | .266100  | .109055      |
| 150.00   | .286025           | .241714   | .263869   | .263869  | .083963      |
| 155.00   | .278710           | .246585   | .262650   | .262650  | .061167      |
| 160.00   | .273003           | .251502   | .262252   | .262252  | .040992      |
| 165.00   | .268729           | .256122   | .262426   | .262426  | .024019      |
| 170.00   | .265770           | .259974   | .262872   | .262872  | .011024      |
| 175.00   | .264433           | .262551   | .263292   | .263292  | .002813      |
| 180.00   | .263460           | .263460   | .263460   | .263460  | .000000      |

TABLE 30. INTENSITY AND POLARIZATION FOR GRAPHITE ( $1 \approx \alpha \approx 25$ )

| MATERIALS PRESENT ARE<br>APRITE $M=$<br>$15\alpha \leq 25$ |                   | 1.59000   | -.660001  | NO OF PARTICLES PER UNIT VOL. = | 4.99680 x 10 <sup>-12</sup> |
|--|-------------------|-----------|-----------|---------------------------------|-----------------------------|
| THETA  | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY                       | POLARIZATION                |
| .00  | 25.675272         | 25.675272 | 25.675272 | 25.675272                       | .000000                     |
| 5.00   | 17.637165         | 17.637165 | 17.637165 | 17.637165                       | .012772                     |
| 10.00  | 9.427844          | 9.427844  | 9.427844  | 9.427844                        | .034398                     |
| 15.00  | 6.147820          | 6.147820  | 6.147820  | 6.147820                        | .058915                     |
| 20.00  | 4.385180          | 4.385180  | 4.385180  | 4.385180                        | .088366                     |
| 25.00  | 3.296759          | 3.296759  | 3.296759  | 3.296759                        | .123294                     |
| 30.00  | 2.506173          | 2.506173  | 2.506173  | 2.506173                        | .163551                     |
| 35.00  | 2.046431          | 2.046431  | 2.046431  | 2.046431                        | .208777                     |
| 40.00  | 1.661788          | 1.661788  | 1.661788  | 1.661788                        | .258544                     |
| 45.00  | 1.369305          | 1.369305  | 1.369305  | 1.369305                        | .312046                     |
| 50.00  | 1.142057          | 1.142057  | 1.142057  | 1.142057                        | .367923                     |
| 55.00  | .962352           | .962352   | .962352   | .962352                         | .424357                     |
| 60.00  | .818318           | .818318   | .818318   | .818318                         | .479113                     |
| 65.00  | .701595           | .701595   | .701595   | .701595                         | .529534                     |
| 70.00  | .606048           | .606048   | .606048   | .606048                         | .572753                     |
| 75.00  | .527328           | .527328   | .527328   | .527328                         | .606076                     |
| 80.00  | .461745           | .461745   | .461745   | .461745                         | .627421                     |
| 85.00  | .407355           | .407355   | .407355   | .407355                         | .635384                     |
| 90.00  | .361556           | .361556   | .361556   | .361556                         | .629743                     |
| 95.00  | .322975           | .322975   | .322975   | .322975                         | .611333                     |
| 100.00   | .290360           | .290360   | .290360   | .290360                         | .581829                     |
| 105.00   | .262714           | .262714   | .262714   | .262714                         | .543509                     |
| 110.00   | .239228           | .239228   | .239228   | .239228                         | .498841                     |
| 115.00   | .219246           | .219246   | .219246   | .219246                         | .450193                     |
| 120.00   | .202237           | .202237   | .202237   | .202237                         | .399651                     |
| 125.00   | .187753           | .187753   | .187753   | .187753                         | .348884                     |
| 130.00   | .175444           | .175444   | .175444   | .175444                         | .298173                     |
| 135.00   | .165008           | .165008   | .165008   | .165008                         | .251433                     |
| 140.00   | .156204           | .156204   | .156204   | .156204                         | .206313                     |
| 145.00   | .148832           | .148832   | .148832   | .148832                         | .164279                     |
| 150.00   | .142730           | .142730   | .142730   | .142730                         | .125722                     |
| 155.00   | .137769           | .137769   | .137769   | .137769                         | .091038                     |
| 160.00   | .133845           | .133845   | .133845   | .133845                         | .060741                     |
| 165.00   | .130876           | .130876   | .130876   | .130876                         | .035530                     |
| 170.00   | .128302           | .128302   | .128302   | .128302                         | .016325                     |
| 175.00   | .125756           | .125756   | .125756   | .125756                         | .004176                     |
| 180.00   | .123171           | .123171   | .123171   | .123171                         | .000000                     |

TABLE 29. INTENSITY AND POLARIZATION FOR GRAPHITE ( $1 \leq \alpha \leq 20$ )

| MATERIALS PRESENT ARE<br>GRAPHITE $M =$<br><b>15 &lt; <math>\alpha</math> &lt; 20</b> |                   | 1.59000   | -.660001  | NO OF PARTICLES PER UNIT VOL. = | 4.999375 x 10 <sup>-12</sup> |
|---|-------------------|-----------|-----------|---------------------------------|------------------------------|
| THETA   | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY                       | POLARIZATION                 |
| 0.00  | 20.938695         | 20.938695 | 20.938695 | 20.938695                       | .000000                      |
| 5.00  | 16.154745         | 15.807337 | 15.807337 | 15.981026                       | .010870                      |
| 10.00   | 9.394130          | 9.777717  | 9.777717  | 9.065923                        | .033921                      |
| 15.00   | 6.107239          | 5.440365  | 5.440365  | 5.773602                        | .057750                      |
| 20.00   | 4.364650          | 3.660713  | 3.660713  | 4.012682                        | .087714                      |
| 25.00   | 3.267372          | 2.570463  | 2.570463  | 2.928917                        | .122385                      |
| 30.00   | 2.557872          | 1.842510  | 1.842510  | 2.200191                        | .162568                      |
| 35.00   | 2.040632          | 1.338538  | 1.338538  | 1.689585                        | .207771                      |
| 40.00   | 1.656873          | .978422   | .978422   | 1.317647                        | .257448                      |
| 45.00   | 1.365378          | .717661   | .717661   | 1.041520                        | .310248                      |
| 50.00   | 1.138600          | .527572   | .527572   | .833086                         | .366725                      |
| 55.00   | .959331           | .388794   | .388794   | .674063                         | .423208                      |
| 60.00   | .815667           | .288087   | .288087   | .551877                         | .477987                      |
| 65.00   | .699188           | .215734   | .215734   | .457446                         | .528461                      |
| 70.00   | .603922           | .164515   | .164515   | .384218                         | .571819                      |
| 75.00   | .525342           | .129167   | .129167   | .327255                         | .605301                      |
| 80.00   | .460128           | .105546   | .105546   | .282837                         | .626831                      |
| 85.00   | .405673           | .090571   | .090571   | .248122                         | .634973                      |
| 90.00   | .359998           | .081834   | .081834   | .220916                         | .629570                      |
| 95.00   | .321520           | .077555   | .077555   | .199537                         | .611325                      |
| 100.00  | .288999           | .076356   | .076356   | .182678                         | .582016                      |
| 105.00  | .261433           | .077251   | .077251   | .169342                         | .543819                      |
| 110.00  | .238019           | .079495   | .079495   | .158757                         | .499269                      |
| 115.00  | .218101           | .082586   | .082586   | .150343                         | .450684                      |
| 120.00  | .201145           | .086196   | .086196   | .143659                         | .400190                      |
| 125.00  | .186713           | .090015   | .090015   | .138364                         | .349432                      |
| 130.00  | .174446           | .093992   | .093992   | .134219                         | .299713                      |
| 135.00  | .164043           | .098021   | .098021   | .131034                         | .251942                      |
| 140.00  | .155275           | .102064   | .102064   | .128670                         | .206774                      |
| 145.00  | .147931           | .106097   | .106097   | .127014                         | .164684                      |
| 150.00  | .141853           | .110094   | .110094   | .125973                         | .126054                      |
| 155.00  | .136911           | .114003   | .114003   | .125457                         | .091297                      |
| 160.00  | .133002           | .117727   | .117727   | .125364                         | .060924                      |
| 165.00  | .130045           | .121094   | .121094   | .125570                         | .035641                      |
| 170.00  | .127979           | .123854   | .123854   | .125917                         | .016378                      |
| 175.00  | .126759           | .125701   | .125701   | .126230                         | .004191                      |
| 180.00  | .126355           | .126355   | .126355   | .126355                         | .000000                      |

TABLE 28. INTENSITY AND POLARIZATION FOR GRAPHITE ( $1 \leq \alpha \leq 15$ )

| MATERIALS PRESENT ARE   |  | 1.59000           | -0.660001 | NO OF PARTICLES PER UNIT VOL. = |              | 4.998518 x 10 <sup>12</sup> |
|-------------------------|--|-------------------|-----------|---------------------------------|--------------|-----------------------------|
| GRAPHITE M <sub>0</sub> |  |                   |           |                                 |              |                             |
|                         |  |                   |           |                                 |              |                             |
| THETA                   |  | GAUSSIAN INTEGRAL |           |                                 |              |                             |
|                         |  | X11 INTEN         | X12 INTEN | INTENSITY                       | POLARIZATION |                             |
| 0.00                    |  | 16.029054         | 16.029054 | 16.029054                       | .000000      |                             |
| 5.00                    |  | 13.681249         | 13.445403 | 13.563326                       | .008694      |                             |
| 10.00                   |  | 9.214025          | 8.658943  | 8.936484                        | .031057      |                             |
| 15.00                   |  | 6.028707          | 5.378130  | 5.703419                        | .057034      |                             |
| 20.00                   |  | 4.330045          | 3.645983  | 3.988014                        | .085765      |                             |
| 25.00                   |  | 3.266600          | 2.561097  | 2.913848                        | .121060      |                             |
| 30.00                   |  | 2.542756          | 1.838445  | 2.190600                        | .160757      |                             |
| 35.00                   |  | 2.030263          | 1.336617  | 1.683440                        | .206021      |                             |
| 40.00                   |  | 1.648006          | .977108   | 1.312557                        | .255569      |                             |
| 45.00                   |  | 1.358502          | .717229   | 1.037866                        | .308939      |                             |
| 50.00                   |  | 1.132567          | .527168   | .829867                         | .364757      |                             |
| 55.00                   |  | .954173           | .388659   | .671416                         | .421136      |                             |
| 60.00                   |  | .811137           | .287910   | .549523                         | .476073      |                             |
| 65.00                   |  | .695107           | .215565   | .455336                         | .526580      |                             |
| 70.00                   |  | .600282           | .164303   | .382293                         | .570215      |                             |
| 75.00                   |  | .522011           | .128912   | .325461                         | .603910      |                             |
| 80.00                   |  | .457083           | .105214   | .281148                         | .625770      |                             |
| 85.00                   |  | .402875           | .090150   | .246512                         | .634297      |                             |
| 90.00                   |  | .357395           | .081350   | .219372                         | .629170      |                             |
| 95.00                   |  | .319105           | .076966   | .198036                         | .611352      |                             |
| 100.00                  |  | .286737           | .075702   | .181219                         | .582263      |                             |
| 105.00                  |  | .259308           | .076510   | .167909                         | .544337      |                             |
| 110.00                  |  | .236016           | .078676   | .157346                         | .499982      |                             |
| 115.00                  |  | .216202           | .081700   | .148951                         | .451495      |                             |
| 120.00                  |  | .199338           | .085210   | .142274                         | .401087      |                             |
| 125.00                  |  | .184989           | .088994   | .136991                         | .350368      |                             |
| 130.00                  |  | .172792           | .092917   | .132855                         | .300609      |                             |
| 135.00                  |  | .162456           | .096892   | .129674                         | .252803      |                             |
| 140.00                  |  | .153738           | .100887   | .127312                         | .207564      |                             |
| 145.00                  |  | .146439           | .104881   | .125660                         | .165359      |                             |
| 150.00                  |  | .140399           | .108841   | .124620                         | .126617      |                             |
| 155.00                  |  | .135489           | .112718   | .124104                         | .091740      |                             |
| 160.00                  |  | .131606           | .116418   | .124012                         | .061235      |                             |
| 165.00                  |  | .128669           | .119768   | .124218                         | .035828      |                             |
| 170.00                  |  | .126616           | .122514   | .124565                         | .014466      |                             |
| 175.00                  |  | .125403           | .124351   | .124877                         | .004213      |                             |
| 180.00                  |  | .125003           | .125003   | .125003                         | .000000      |                             |

TABLE 27. INTENSITY AND POLARIZATION FOR GRAPHITE ( $1 \leq \alpha \leq 10$ )

| MATERIALS PRESENT ARE<br>GRAPHITE $\alpha =$<br>$1 \leq \alpha \leq 10$ |                   |           | 1.59000   | -.660001  | NO OF PARTICLES PER UNIT VOL. = $4.995000 \times 10^{12}$ |              |  |  |
|---|-------------------|-----------|-----------|-----------|---|--------------|--|--|
| THETA   | GAUSSIAN INTEGRAL |           | XI1 INTEN | XI2 INTEN | INTENSITY   | POLARIZATION |  |  |
| .00   | 10.846922         | 10.846922 | 10.846922 | 10.846922 | 10.846922   | .000000      |  |  |
| 5.00  | 10.026599         | 9.898820  | 9.898820  | 9.898820  | 9.962709  | .006413      |  |  |
| 10.00   | 8.047525          | 7.657168  | 7.657168  | 7.657168  | 7.952346  | .024856      |  |  |
| 15.00   | 5.897670          | 5.311819  | 5.311819  | 5.311819  | 5.604744  | .052264      |  |  |
| 20.00   | 4.256307          | 3.598913  | 3.598913  | 3.598913  | 3.927610  | .083689      |  |  |
| 25.00   | 3.200531          | 2.527449  | 2.527449  | 2.527449  | 2.863990  | .117508      |  |  |
| 30.00   | 2.509536          | 1.828943  | 1.828943  | 1.828943  | 2.169239  | .156874      |  |  |
| 35.00   | 2.007527          | 1.331650  | 1.331650  | 1.331650  | 1.669589  | .202408      |  |  |
| 40.00   | 1.628521          | .973368   | .973368   | .973368   | 1.300944  | .251799      |  |  |
| 45.00   | 1.342331          | .715529   | .715529   | .715529   | 1.028930  | .304590      |  |  |
| 50.00   | 1.120456          | .526575   | .526575   | .526575   | .823515   | .360577      |  |  |
| 55.00   | .943480           | .388039   | .388039   | .388039   | .665760   | .417148      |  |  |
| 60.00   | .801467           | .287646   | .287646   | .287646   | .544557   | .471779      |  |  |
| 65.00   | .686850           | .215264   | .215264   | .215264   | .451057   | .52757       |  |  |
| 70.00   | .592954           | .163872   | .163872   | .163872   | .378413   | .566949      |  |  |
| 75.00   | .515306           | .128423   | .128423   | .128423   | .321865   | .601002      |  |  |
| 80.00   | .450937           | .104627   | .104627   | .104627   | .277782   | .623349      |  |  |
| 85.00   | .397296           | .089323   | .089323   | .089323   | .243310   | .632883      |  |  |
| 90.00   | .352260           | .080347   | .080347   | .080347   | .216304   | .628546      |  |  |
| 95.00   | .314298           | .075875   | .075875   | .075875   | .195087   | .611068      |  |  |
| 100.00  | .282249           | .074422   | .074422   | .074422   | .178335   | .582684      |  |  |
| 105.00  | .255115           | .075030   | .075030   | .075030   | .165072   | .545475      |  |  |
| 110.00  | .232066           | .077059   | .077059   | .077059   | .154562   | .501437      |  |  |
| 115.00  | .212855           | .079964   | .079964   | .079964   | .146209   | .453085      |  |  |
| 120.00  | .195773           | .083338   | .083338   | .083338   | .139555   | .402832      |  |  |
| 125.00  | .181589           | .086974   | .086974   | .086974   | .134281   | .352298      |  |  |
| 130.00  | .169537           | .090778   | .090778   | .090778   | .130157   | .302554      |  |  |
| 135.00  | .159321           | .094668   | .094668   | .094668   | .126995   | .254552      |  |  |
| 140.00  | .150705           | .098577   | .098577   | .098577   | .124641   | .209112      |  |  |
| 145.00  | .143496           | .102478   | .102478   | .102478   | .122987   | .166760      |  |  |
| 150.00  | .137534           | .106359   | .106359   | .106359   | .121947   | .127822      |  |  |
| 155.00  | .132688           | .110182   | .110182   | .110182   | .121435   | .092668      |  |  |
| 160.00  | .128855           | .113841   | .113841   | .113841   | .121348   | .061964      |  |  |
| 165.00  | .125954           | .117156   | .117156   | .117156   | .121555   | .036192      |  |  |
| 170.00  | .123926           | .119873   | .119873   | .119873   | .121899   | .016625      |  |  |
| 175.00  | .122726           | .121687   | .121687   | .121687   | .122207   | .004251      |  |  |
| 180.00  | .122330           | .122330   | .122330   | .122330   | .122330   | .000000      |  |  |



TABLE 26. INTENSITY AND POLARIZATION FOR GRAPHITE ( $1 \leq \alpha \leq 5$ )

| MATERIALS PRESENT ARE<br>GRAPHITE $\alpha =$<br>$1 \leq \alpha \leq 5$ |                   | 1.59000   | 0.000001  | NO OF PARTICLES PER UNIT VOL. = $4.960000 \times 10^{-12}$ |              |  |
|--|-------------------|-----------|-----------|--|--------------|--|
| THETA  | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY  | POLARIZATION |  |
| 0.00   | 5.160944          | 5.160944  | 5.160944  | 5.160944   | 0.00000      |  |
| 5.00   | 5.036142          | 4.993562  | 4.993562  | 5.014852   | 0.004245     |  |
| 10.00  | 4.684192          | 4.527871  | 4.527871  | 4.656032   | 0.016969     |  |
| 15.00  | 4.165662          | 3.860030  | 3.860030  | 4.012846   | 0.038082     |  |
| 20.00  | 3.561602          | 3.112652  | 3.112652  | 3.337127   | 0.07266      |  |
| 25.00  | 2.952008          | 2.396989  | 2.396989  | 2.674498   | 0.103761     |  |
| 30.00  | 2.398136          | 1.786289  | 1.786289  | 2.092212   | 0.146220     |  |
| 35.00  | 1.933813          | 1.308425  | 1.308425  | 1.621119   | 0.192888     |  |
| 40.00  | 1.566505          | 0.955544  | 0.955544  | 1.261054   | 0.242266     |  |
| 45.00  | 1.285545          | 0.701661  | 0.701661  | 0.993603   | 0.293622     |  |
| 50.00  | 1.071613          | 0.518517  | 0.518517  | 0.795065   | 0.347830     |  |
| 55.00  | 0.905560          | 0.384307  | 0.384307  | 0.649933   | 0.404113     |  |
| 60.00  | 0.772592          | 0.285205  | 0.285205  | 0.528898   | 0.460757     |  |
| 65.00  | 0.663241          | 0.212895  | 0.212895  | 0.430068   | 0.514014     |  |
| 70.00  | 0.572127          | 0.161579  | 0.161579  | 0.368853   | 0.559554     |  |
| 75.00  | 0.496128          | 0.126305  | 0.126305  | 0.311217   | 0.594157     |  |
| 80.00  | 0.432986          | 0.102696  | 0.102696  | 0.267842   | 0.616571     |  |
| 85.00  | 0.380633          | 0.087281  | 0.087281  | 0.233957   | 0.626936     |  |
| 90.00  | 0.337088          | 0.077648  | 0.077648  | 0.207368   | 0.625555     |  |
| 95.00  | 0.300594          | 0.072275  | 0.072275  | 0.186435   | 0.612328     |  |
| 100.00   | 0.269743          | 0.070134  | 0.070134  | 0.169938   | 0.587295     |  |
| 105.00   | 0.243493          | 0.070374  | 0.070374  | 0.156932   | 0.551561     |  |
| 110.00   | 0.221088          | 0.072249  | 0.072249  | 0.146648   | 0.507605     |  |
| 115.00   | 0.201983          | 0.074957  | 0.074957  | 0.138470   | 0.458675     |  |
| 120.00   | 0.185729          | 0.078127  | 0.078127  | 0.131928   | 0.407806     |  |
| 125.00   | 0.171942          | 0.081444  | 0.081444  | 0.126693   | 0.357154     |  |
| 130.00   | 0.160279          | 0.084812  | 0.084812  | 0.122546   | 0.307913     |  |
| 135.00   | 0.150441          | 0.088235  | 0.088235  | 0.119338   | 0.260627     |  |
| 140.00   | 0.142173          | 0.091746  | 0.091746  | 0.116959   | 0.215572     |  |
| 145.00   | 0.135265          | 0.095366  | 0.095366  | 0.115315   | 0.173002     |  |
| 150.00   | 0.129552          | 0.099081  | 0.099081  | 0.114317   | 0.133273     |  |
| 155.00   | 0.124903          | 0.102831  | 0.102831  | 0.113867   | 0.096921     |  |
| 160.00   | 0.121218          | 0.106478  | 0.106478  | 0.113848   | 0.064734     |  |
| 165.00   | 0.118422          | 0.109802  | 0.109802  | 0.114112   | 0.037772     |  |
| 170.00   | 0.116462          | 0.112508  | 0.112508  | 0.114485   | 0.017268     |  |
| 175.00   | 0.115300          | 0.114291  | 0.114291  | 0.114796   | 0.004394     |  |
| 180.00   | 0.114915          | 0.114915  | 0.114915  | 0.114915   | 0.000000     |  |

TABLE 25. INTENSITY AND POLARIZATION FOR ICE II ( $1 \leq \alpha \leq 25$ )

| MATERIALS PRESENT ARE |                   |           | NO OF PARTICLES PER UNIT VOL. = |           |              | 4.999680 x 10 <sup>-12</sup> |  |  |
|-----------------------|-------------------|-----------|---------------------------------|-----------|--------------|------------------------------|--|--|
| ICE M =               |                   |           | 1.000001                        |           |              |                              |  |  |
| 15-25                 |                   |           |                                 |           |              |                              |  |  |
| THETA                 | GAUSSIAN INTEGRAL |           | K12 INTEN                       | INTENSITY | POLARIZATION |                              |  |  |
|                       | K11 INTEN         | K12 INTEN |                                 |           |              |                              |  |  |
| 0.00                  | 25.958688         | 25.958688 | 25.958688                       | 25.958688 | 0.000000     |                              |  |  |
| 5.00                  | 17.601857         | 17.601857 | 17.601857                       | 17.601857 | 0.01434      |                              |  |  |
| 10.00                 | 9.121824          | 9.121824  | 9.121824                        | 9.121824  | 0.05683      |                              |  |  |
| 15.00                 | 5.629877          | 5.629877  | 5.629877                        | 5.629877  | 0.13450      |                              |  |  |
| 20.00                 | 3.744490          | 3.744490  | 3.744490                        | 3.744490  | 0.25620      |                              |  |  |
| 25.00                 | 2.604958          | 2.604958  | 2.604958                        | 2.604958  | 0.42365      |                              |  |  |
| 30.00                 | 1.873259          | 1.873259  | 1.873259                        | 1.873259  | 0.65733      |                              |  |  |
| 35.00                 | 1.382784          | 1.382784  | 1.382784                        | 1.382784  | 0.94631      |                              |  |  |
| 40.00                 | 1.043275          | 1.043275  | 1.043275                        | 1.043275  | 1.29811      |                              |  |  |
| 45.00                 | 0.802697          | 0.802697  | 0.802697                        | 0.802697  | 1.71414      |                              |  |  |
| 50.00                 | 0.628506          | 0.628506  | 0.628506                        | 0.628506  | 2.17328      |                              |  |  |
| 55.00                 | 0.499850          | 0.499850  | 0.499850                        | 0.499850  | 2.73149      |                              |  |  |
| 60.00                 | 0.403243          | 0.403243  | 0.403243                        | 0.403243  | 3.32105      |                              |  |  |
| 65.00                 | 0.329591          | 0.329591  | 0.329591                        | 0.329591  | 3.94865      |                              |  |  |
| 70.00                 | 0.272645          | 0.272645  | 0.272645                        | 0.272645  | 4.59495      |                              |  |  |
| 75.00                 | 0.228066          | 0.228066  | 0.228066                        | 0.228066  | 5.23389      |                              |  |  |
| 80.00                 | 0.192829          | 0.192829  | 0.192829                        | 0.192829  | 5.83255      |                              |  |  |
| 85.00                 | 0.164662          | 0.164662  | 0.164662                        | 0.164662  | 6.35382      |                              |  |  |
| 90.00                 | 0.141967          | 0.141967  | 0.141967                        | 0.141967  | 6.75945      |                              |  |  |
| 95.00                 | 0.123540          | 0.123540  | 0.123540                        | 0.123540  | 7.01510      |                              |  |  |
| 100.00                | 0.108483          | 0.108483  | 0.108483                        | 0.108483  | 7.09698      |                              |  |  |
| 105.00                | 0.096128          | 0.096128  | 0.096128                        | 0.096128  | 6.99474      |                              |  |  |
| 110.00                | 0.085935          | 0.085935  | 0.085935                        | 0.085935  | 6.71510      |                              |  |  |
| 115.00                | 0.077508          | 0.077508  | 0.077508                        | 0.077508  | 6.27965      |                              |  |  |
| 120.00                | 0.070528          | 0.070528  | 0.070528                        | 0.070528  | 5.72040      |                              |  |  |
| 125.00                | 0.064748          | 0.064748  | 0.064748                        | 0.064748  | 5.07565      |                              |  |  |
| 130.00                | 0.059969          | 0.059969  | 0.059969                        | 0.059969  | 4.38251      |                              |  |  |
| 135.00                | 0.056031          | 0.056031  | 0.056031                        | 0.056031  | 3.67523      |                              |  |  |
| 140.00                | 0.052802          | 0.052802  | 0.052802                        | 0.052802  | 2.98096      |                              |  |  |
| 145.00                | 0.050170          | 0.050170  | 0.050170                        | 0.050170  | 2.32127      |                              |  |  |
| 150.00                | 0.048038          | 0.048038  | 0.048038                        | 0.048038  | 1.71209      |                              |  |  |
| 155.00                | 0.046314          | 0.046314  | 0.046314                        | 0.046314  | 1.16812      |                              |  |  |
| 160.00                | 0.044917          | 0.044917  | 0.044917                        | 0.044917  | 0.70779      |                              |  |  |
| 165.00                | 0.043797          | 0.043797  | 0.043797                        | 0.043797  | 0.36049      |                              |  |  |
| 170.00                | 0.043024          | 0.043024  | 0.043024                        | 0.043024  | 0.15075      |                              |  |  |
| 175.00                | 0.042779          | 0.042779  | 0.042779                        | 0.042779  | 0.04334      |                              |  |  |
| 180.00                | 0.042830          | 0.042830  | 0.042830                        | 0.042830  | 0.000000     |                              |  |  |

TABLE 24. INTENSITY AND POLARIZATION FOR ICE II ( $1 \leq \alpha \leq 20$ )

| MATERIALS PRESENT ARE |                   | 1.41000   | -4.100001 | NO OF PARTICLES PER UNIT VOL. = |              | 4.999375 x 10 <sup>12</sup> |
|-----------------------|-------------------|-----------|-----------|---------------------------------|--------------|-----------------------------|
| ZINC H <sub>2</sub>   |                   |           |           |                                 |              |                             |
| 1 ≤ α ≤ 20            |                   |           |           |                                 |              |                             |
| THETA                 | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY                       | POLARIZATION |                             |
| •00                   | 25.108830         | 25.108830 | 25.108830 | 25.108830                       | •000000      |                             |
| 5•00                  | 19.7797517        | 18.604254 | 18.604254 | 19.200886                       | •031073      |                             |
| 10•00                 | 12.237204         | 10.476111 | 10.476111 | 11.356658                       | •077536      |                             |
| 15•00                 | 8.529610          | 6.816794  | 6.816794  | 7.673204                        | •111610      |                             |
| 20•00                 | 6.549356          | 4.815581  | 4.815581  | 5.682470                        | •152555      |                             |
| 25•00                 | 5.305215          | 3.574764  | 3.574764  | 4.439989                        | •194871      |                             |
| 30•00                 | 4.445023          | 2.747748  | 2.747748  | 3.596386                        | •235769      |                             |
| 35•00                 | 3.818937          | 2.170177  | 2.170177  | 2.994557                        | •275293      |                             |
| 40•00                 | 3.340116          | 1.768275  | 1.768275  | 2.554206                        | •307693      |                             |
| 45•00                 | 2.964144          | 1.463064  | 1.463064  | 2.223604                        | •333036      |                             |
| 50•00                 | 2.660781          | 1.285615  | 1.285615  | 1.973198                        | •348461      |                             |
| 55•00                 | 2.411759          | 1.151202  | 1.151202  | 1.761481                        | •353795      |                             |
| 60•00                 | 2.204100          | 1.061802  | 1.061802  | 1.632951                        | •349765      |                             |
| 65•00                 | 2.028663          | 1.006292  | 1.006292  | 1.517578                        | •336909      |                             |
| 70•00                 | 1.879809          | .972320   | .972320   | 1.425965                        | •318131      |                             |
| 75•00                 | 1.751464          | .954389   | .954389   | 1.352936                        | •294580      |                             |
| 80•00                 | 1.640947          | .944627   | .944627   | 1.292787                        | •269309      |                             |
| 85•00                 | 1.545173          | .940316   | .940316   | 1.242744                        | •243356      |                             |
| 90•00                 | 1.462069          | .937036   | .937036   | 1.199552                        | •218645      |                             |
| 95•00                 | 1.369899          | .933905   | .933905   | 1.161902                        | •196227      |                             |
| 100•00                | 1.327354          | .928949   | .928949   | 1.128151                        | •176574      |                             |
| 105•00                | 1.273321          | .922650   | .922650   | 1.097966                        | •159688      |                             |
| 110•00                | 1.226934          | .914625   | .914625   | 1.070780                        | •145632      |                             |
| 115•00                | 1.187449          | .906257   | .906257   | 1.046853                        | •134303      |                             |
| 120•00                | 1.154251          | .898006   | .898006   | 1.026168                        | •124616      |                             |
| 125•00                | 1.126811          | .891836   | .891836   | 1.009323                        | •116402      |                             |
| 130•00                | 1.104647          | .884600   | .884600   | .996553                         | •108468      |                             |
| 135•00                | 1.087342          | .889381   | .889381   | .988362                         | •100146      |                             |
| 140•00                | 1.074464          | .895534   | .895534   | .984499                         | •090628      |                             |
| 145•00                | 1.065614          | .907466   | .907466   | .986546                         | •080153      |                             |
| 150•00                | 1.060346          | .925547   | .925547   | .992946                         | •067878      |                             |
| 155•00                | 1.056168          | .949111   | .949111   | 1.003640                        | •054331      |                             |
| 160•00                | 1.058530          | .977045   | .977045   | 1.017786                        | •040031      |                             |
| 165•00                | 1.060729          | 1.007101  | 1.007101  | 1.033945                        | •025905      |                             |
| 170•00                | 1.063909          | 1.035992  | 1.035992  | 1.049951                        | •013294      |                             |
| 175•00                | 1.066947          | 1.066947  | 1.066947  | 1.062857                        | •003648      |                             |
| 180•00                | 1.068273          | 1.068273  | 1.068273  | 1.068273                        | •000000      |                             |

TABLE 23. INTENSITY AND POLARIZATION FOR ICE II ( $1 \leq \alpha \leq 15$ )

| MATERIALS PRESENT ARE |                   | 1.33000    | 1.100001   | NO OF PARTICLES PER UNIT VOL. = |  | 4.998518 x 10 <sup>-12</sup> |
|-----------------------|-------------------|------------|------------|---------------------------------|--|------------------------------|
| ICE II =              |                   |            |            |                                 |  |                              |
| 15 Å ± 15             |                   |            |            |                                 |  |                              |
| THETA                 | GAUSSIAN INTEGRAL |            |            |                                 |  |                              |
|                       | X11 INTEN         | X12 INTEN  | INTENSITY  | POLARIZATION                    |  |                              |
| 0.00                  | 16.326361         | 16.326361  | 16.326361  | .000000                         |  |                              |
| 5.00                  | 13.770509         | 13.7538182 | 13.7538182 | .001175                         |  |                              |
| 10.00                 | 8.943652          | 8.855257   | 8.855257   | .004966                         |  |                              |
| 15.00                 | 5.529507          | 5.393529   | 5.393529   | .012449                         |  |                              |
| 20.00                 | 3.705032          | 3.528012   | 3.528012   | .024474                         |  |                              |
| 25.00                 | 2.585211          | 2.379345   | 2.379345   | .041467                         |  |                              |
| 30.00                 | 1.860662          | 1.636063   | 1.636063   | .064231                         |  |                              |
| 35.00                 | 1.374133          | 1.140698   | 1.140698   | .092823                         |  |                              |
| 40.00                 | 1.036499          | .801402    | .801402    | .127916                         |  |                              |
| 45.00                 | .798068           | .566875    | .566875    | .169379                         |  |                              |
| 50.00                 | .624161           | .401499    | .401499    | .217091                         |  |                              |
| 55.00                 | .496746           | .284938    | .284938    | .270983                         |  |                              |
| 60.00                 | .400421           | .201825    | .201825    | .329759                         |  |                              |
| 65.00                 | .327284           | .142744    | .142744    | .392613                         |  |                              |
| 70.00                 | .270738           | .100801    | .100801    | .457386                         |  |                              |
| 75.00                 | .226326           | .071222    | .071222    | .521276                         |  |                              |
| 80.00                 | .191410           | .050625    | .050625    | .581670                         |  |                              |
| 85.00                 | .163350           | .036590    | .036590    | .633989                         |  |                              |
| 90.00                 | .140815           | .027322    | .027322    | .675004                         |  |                              |
| 95.00                 | .122540           | .021508    | .021508    | .701379                         |  |                              |
| 100.00                | .107549           | .018261    | .018261    | .709712                         |  |                              |
| 105.00                | .095299           | .016799    | .016799    | .700284                         |  |                              |
| 110.00                | .085176           | .016659    | .016659    | .672828                         |  |                              |
| 115.00                | .076793           | .017475    | .017475    | .629249                         |  |                              |
| 120.00                | .069882           | .018921    | .018921    | .573866                         |  |                              |
| 125.00                | .064140           | .020845    | .020845    | .509444                         |  |                              |
| 130.00                | .059392           | .023110    | .023110    | .439772                         |  |                              |
| 135.00                | .055494           | .025568    | .025568    | .369180                         |  |                              |
| 140.00                | .052288           | .028183    | .028183    | .299546                         |  |                              |
| 145.00                | .049670           | .030895    | .030895    | .233049                         |  |                              |
| 150.00                | .047561           | .033601    | .033601    | .172003                         |  |                              |
| 155.00                | .045857           | .036210    | .036210    | .117554                         |  |                              |
| 160.00                | .044466           | .038555    | .038555    | .071199                         |  |                              |
| 165.00                | .043355           | .040332    | .040332    | .036118                         |  |                              |
| 170.00                | .042578           | .041299    | .041299    | .015246                         |  |                              |
| 175.00                | .042331           | .041974    | .041974    | .004233                         |  |                              |
| 180.00                | .042375           | .042375    | .042375    | .000000                         |  |                              |

TABLE 22. INTENSITY AND POLARIZATION FOR ICE II ( $1 \leq \alpha \leq 10$ )

| MATERIALS PRESENT ARE |  | 1.33000   | -.1000001 | NO OF PARTICLES PER UNIT VOL. = $4.995000 \times 10^{12}$ |              |
|-----------------------|--|-----------|-----------|---|--------------|
| ICE # =               |  |           |           |   |              |
| 15 NS 10              |  |           |           |   |              |
| GAUSSIAN INTEGRAL     |  |           |           |   |              |
| THETA                 |  | XI1 INTEN | XI2 INTEN | INTENSITY   | POLARIZATION |
| .00                   |  | 11.254725 | 11.254725 | 11.254725   | .000000      |
| 5.00                  |  | 10.279052 | 10.254393 | 10.266722   | .001201      |
| 10.00                 |  | 7.945736  | 7.868850  | 7.907293  | .004862      |
| 15.00                 |  | 5.463414  | 5.335152  | 5.401283  | .011503      |
| 20.00                 |  | 3.639897  | 3.478002  | 3.558949  | .022745      |
| 25.00                 |  | 2.530214  | 2.33275   | 2.432244  | .040280      |
| 30.00                 |  | 1.840005  | 1.619682  | 1.729843  | .063683      |
| 35.00                 |  | 1.359045  | 1.129516  | 1.244281  | .092234      |
| 40.00                 |  | 1.019933  | .789827   | .904880   | .127147      |
| 45.00                 |  | .786624   | .558707   | .672665   | .169413      |
| 50.00                 |  | .618142   | .396961   | .507551   | .217890      |
| 55.00                 |  | .490329   | .280927   | .385628   | .271508      |
| 60.00                 |  | .394785   | .198613   | .296699   | .330591      |
| 65.00                 |  | .323497   | .140492   | .231994   | .394418      |
| 70.00                 |  | .267856   | .091113   | .183484   | .459827      |
| 75.00                 |  | .223552   | .069887   | .146719   | .523670      |
| 80.00                 |  | .188804   | .049377   | .119230   | .584193      |
| 85.00                 |  | .161564   | .035679   | .098622   | .638222      |
| 90.00                 |  | .139289   | .026527   | .082908   | .680046      |
| 95.00                 |  | .120988   | .020885   | .070937   | .705578      |
| 100.00                |  | .106201   | .017691   | .061946   | .714418      |
| 105.00                |  | .094200   | .016214   | .055207   | .706306      |
| 110.00                |  | .084201   | .016060   | .050131   | .679631      |
| 115.00                |  | .075831   | .015919   | .046375   | .635174      |
| 120.00                |  | .068961   | .018432   | .043696   | .578173      |
| 125.00                |  | .063344   | .020312   | .041828   | .514388      |
| 130.00                |  | .058673   | .022483   | .0400578  | .445930      |
| 135.00                |  | .054779   | .024969   | .039874   | .373810      |
| 140.00                |  | .051571   | .027645   | .039608   | .302033      |
| 145.00                |  | .048957   | .030324   | .039640   | .235029      |
| 150.00                |  | .046889   | .032988   | .039939   | .174025      |
| 155.00                |  | .045271   | .035612   | .040041   | .119421      |
| 160.00                |  | .043875   | .037868   | .040871   | .073481      |
| 165.00                |  | .042650   | .039473   | .041062   | .038689      |
| 170.00                |  | .041895   | .040590   | .041243   | .015817      |
| 175.00                |  | .041737   | .041432   | .041585   | .003665      |
| 180.00                |  | .041787   | .041787   | .041787   | .000000      |

TABLE 21. INTENSITY AND POLARIZATION FOR ICE II ( $1 \leq \alpha \leq 5$ )

| MATERIALS PRESENT ARE<br>ICE II<br>$1 \leq \alpha \leq 5$ |  | 1.33000           | -.100001  | NO OF PARTICLES PER UNIT VOL. = $4.980000 \times 10^{12}$ |           |              |
|---|--|-------------------|-----------|---|-----------|--------------|
| THETA   |  | GAUSSIAN INTEGRAL |           | X12 INTEN   | INTENSITY | POLARIZATION |
|   |  | X11 INTEN         | X12 INTEN |   |           |              |
| 5.00  |  | 4.169200          | 4.169200  | 4.169200  | 4.169200  | .000000      |
| 10.00   |  | 4.057867          | 4.040176  | 4.049021  | 4.049021  | .002185      |
| 15.00   |  | 3.743139          | 3.678295  | 3.710717  | 3.710717  | .008737      |
| 20.00   |  | 3.277463          | 3.151103  | 3.214283  | 3.214283  | .019656      |
| 25.00   |  | 2.732345          | 2.547808  | 2.640077  | 2.640077  | .034949      |
| 30.00   |  | 2.180506          | 1.954454  | 2.067480  | 2.067480  | .054669      |
| 35.00   |  | 1.680241          | 1.434239  | 1.557240  | 1.557240  | .078987      |
| 40.00   |  | 1.266382          | 1.018829  | 1.142606  | 1.142606  | .108328      |
| 45.00   |  | .949308           | .711043   | .830176   | .830176   | .143502      |
| 50.00   |  | .720417           | .494834   | .607626   | .607626   | .185627      |
| 55.00   |  | .560738           | .346874   | .453806   | .453806   | .235634      |
| 60.00   |  | .449169           | .245320   | .347244   | .347244   | .293523      |
| 65.00   |  | .368004           | .174013   | .271039   | .271039   | .357978      |
| 70.00   |  | .305531           | .122792   | .214146   | .214146   | .426600      |
| 75.00   |  | .254894           | .085800   | .170347   | .170347   | .496323      |
| 80.00   |  | .213259           | .059498   | .136379   | .136379   | .563727      |
| 85.00   |  | .179331           | .041136   | .110333   | .110333   | .625356      |
| 90.00   |  | .152237           | .029198   | .090718   | .090718   | .678142      |
| 95.00   |  | .130928           | .021346   | .076137   | .076137   | .719635      |
| 100.00  |  | .114157           | .016477   | .065317   | .065317   | .747744      |
| 105.00  |  | .100712           | .013720   | .057216   | .057216   | .760206      |
| 110.00  |  | .089631           | .012542   | .051087   | .051087   | .754506      |
| 115.00  |  | .080291           | .012603   | .046447   | .046447   | .728661      |
| 120.00  |  | .072347           | .013695   | .042996   | .042996   | .682634      |
| 125.00  |  | .065615           | .015430   | .040523   | .040523   | .619231      |
| 130.00  |  | .059962           | .017719   | .038840   | .038840   | .543804      |
| 135.00  |  | .055240           | .020293   | .037767   | .037767   | .462669      |
| 140.00  |  | .051298           | .022975   | .037137   | .037137   | .381339      |
| 145.00  |  | .048012           | .025644   | .036828   | .036828   | .303678      |
| 150.00  |  | .045315           | .028239   | .036777   | .036777   | .232163      |
| 155.00  |  | .043203           | .030738   | .036971   | .036971   | .168587      |
| 160.00  |  | .041690           | .033125   | .037407   | .037407   | .114484      |
| 165.00  |  | .040759           | .035354   | .038057   | .038057   | .071004      |
| 170.00  |  | .040322           | .037330   | .038826   | .038826   | .038531      |
| 175.00  |  | .040220           | .038909   | .039565   | .039565   | .016559      |
| 180.00  |  | .040263           | .039939   | .040101   | .040101   | .004042      |
|   |  | .040297           | .040297   | .040297   | .040297   | .000000      |

TABLE 20. INTENSITY AND POLARIZATION FOR ICE I ( $1 \leq \alpha \leq 25$ )

| MATERIALS PRESENT ARE<br>ICE H= |                   |  | NO OF PARTICLES PER UNIT VOL. = |           |              | 4.999680 x 10 <sup>12</sup> |  |  |
|---------------------------------|-------------------|--|---------------------------------|-----------|--------------|-----------------------------|--|--|
| 1.33000                         |                   |  | --0.050001                      |           |              |                             |  |  |
| 164525                          |                   |  |                                 |           |              |                             |  |  |
| THETA                           | GAUSSIAN INTEGRAL |  | X12 INTEN                       | INTENSITY | POLARIZATION |                             |  |  |
|                                 | X11 INTEN         |  |                                 |           |              |                             |  |  |
| 0.00                            | 28.122536         |  | 28.122536                       | 28.122536 | .000000      |                             |  |  |
| 5.00                            | 19.480953         |  | 19.487238                       | 19.484097 | -.000161     |                             |  |  |
| 10.00                           | 10.536798         |  | 10.510924                       | 10.523861 | .001229      |                             |  |  |
| 15.00                           | 6.673473          |  | 6.600756                        | 6.637114  | .005478      |                             |  |  |
| 20.00                           | 4.494613          |  | 4.375773                        | 4.435193  | .013397      |                             |  |  |
| 25.00                           | 3.134137          |  | 2.977575                        | 3.055856  | .025617      |                             |  |  |
| 30.00                           | 2.245288          |  | 2.061008                        | 2.153148  | .042793      |                             |  |  |
| 35.00                           | 1.645675          |  | 1.443511                        | 1.544593  | .065443      |                             |  |  |
| 40.00                           | 1.230275          |  | 1.019365                        | 1.124820  | .093753      |                             |  |  |
| 45.00                           | .937631           |  | .724783                         | .831207   | .128036      |                             |  |  |
| 50.00                           | .727224           |  | .517791                         | .622507   | .168217      |                             |  |  |
| 55.00                           | .573104           |  | .371090                         | .472097   | .213954      |                             |  |  |
| 60.00                           | .458653           |  | .266627                         | .362640   | .264762      |                             |  |  |
| 65.00                           | .372202           |  | .191964                         | .282083   | .319476      |                             |  |  |
| 70.00                           | .306005           |  | .138613                         | .222309   | .376485      |                             |  |  |
| 75.00                           | .254780           |  | .100626                         | .177703   | .433740      |                             |  |  |
| 80.00                           | .214601           |  | .073784                         | .144192   | .488295      |                             |  |  |
| 85.00                           | .182813           |  | .055073                         | .118943   | .536982      |                             |  |  |
| 90.00                           | .157469           |  | .042306                         | .099888   | .576460      |                             |  |  |
| 95.00                           | .137078           |  | .033916                         | .085497   | .603309      |                             |  |  |
| 100.00                          | .120619           |  | .028725                         | .074672   | .615322      |                             |  |  |
| 105.00                          | .107268           |  | .025897                         | .066583   | .611048      |                             |  |  |
| 110.00                          | .096423           |  | .024811                         | .060617   | .590695      |                             |  |  |
| 115.00                          | .087635           |  | .025005                         | .056320   | .556019      |                             |  |  |
| 120.00                          | .080537           |  | .026183                         | .053350   | .509595      |                             |  |  |
| 125.00                          | .074869           |  | .028035                         | .051452   | .455130      |                             |  |  |
| 130.00                          | .070405           |  | .030461                         | .050433   | .396009      |                             |  |  |
| 135.00                          | .066976           |  | .033314                         | .050145   | .335646      |                             |  |  |
| 140.00                          | .064412           |  | .036517                         | .050164   | .276389      |                             |  |  |
| 145.00                          | .062551           |  | .040020                         | .051285   | .219661      |                             |  |  |
| 150.00                          | .061196           |  | .043809                         | .052503   | .165582      |                             |  |  |
| 155.00                          | .060101           |  | .047877                         | .053989   | .113207      |                             |  |  |
| 160.00                          | .058958           |  | .052052                         | .055505   | .062210      |                             |  |  |
| 165.00                          | .057361           |  | .055431                         | .056396   | .017118      |                             |  |  |
| 170.00                          | .055289           |  | .055289                         | .055594   | -.005478     |                             |  |  |
| 175.00                          | .054850           |  | .054848                         | .054899   | -.000895     |                             |  |  |
| 180.00                          | .056141           |  | .056141                         | .056141   | .000000      |                             |  |  |





TABLE 18. INTENSITY AND POLARIZATION FOR ICE I ( $1 \leq \alpha \leq 15$ )

| MATERIALS PRESENT ARE<br>ICE H= |                   | 1.33000   | -.050001  | NO OF PARTICLES PER UNIT VOL. = | 4.998518 x 10 <sup>-12</sup> |
|---------------------------------|-------------------|-----------|-----------|---------------------------------|------------------------------|
| 1 ≤ α ≤ 15                      |                   |           |           |                                 |                              |
| THETA                           | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY                       | POLARIZATION                 |
| .00                             | 18.254628         | 18.254628 | 18.254628 | 18.254628                       | .000000                      |
| 5.00                            | 15.519937         | 15.519937 | 15.519937 | 15.519937                       | .000035                      |
| 10.00                           | 10.331437         | 10.331437 | 10.331437 | 10.331437                       | .000225                      |
| 15.00                           | 6.569182          | 6.569182  | 6.569182  | 6.537889                        | .004786                      |
| 20.00                           | 4.448129          | 4.448129  | 4.439257  | 4.393693                        | .012390                      |
| 25.00                           | 3.111398          | 3.111398  | 2.963493  | 3.037446                        | .024347                      |
| 30.00                           | 2.233048          | 2.233048  | 2.054908  | 2.143978                        | .041544                      |
| 35.00                           | 1.634150          | 1.634150  | 1.438332  | 1.536241                        | .063733                      |
| 40.00                           | 1.222429          | 1.222429  | 1.015690  | 1.119060                        | .092372                      |
| 45.00                           | .931530           | .931530   | .722080   | .826805                         | .126662                      |
| 50.00                           | .721260           | .721260   | .514928   | .618094                         | .166910                      |
| 55.00                           | .569281           | .569281   | .369145   | .469213                         | .213267                      |
| 60.00                           | .454794           | .454794   | .264817   | .359805                         | .264000                      |
| 65.00                           | .369318           | .369318   | .190545   | .279931                         | .319315                      |
| 70.00                           | .303677           | .303677   | .137484   | .220580                         | .376719                      |
| 75.00                           | .252611           | .252611   | .099705   | .176158                         | .434002                      |
| 80.00                           | .213016           | .213016   | .073018   | .143017                         | .489445                      |
| 85.00                           | .181315           | .181315   | .054459   | .117887                         | .538039                      |
| 90.00                           | .156222           | .156222   | .041791   | .099006                         | .577898                      |
| 95.00                           | .136038           | .136038   | .033429   | .084734                         | .605478                      |
| 100.00                          | .119632           | .119632   | .028346   | .073989                         | .616894                      |
| 105.00                          | .106441           | .106441   | .025499   | .065970                         | .613474                      |
| 110.00                          | .095669           | .095669   | .024440   | .060055                         | .593042                      |
| 115.00                          | .086922           | .086922   | .024659   | .055790                         | .558007                      |
| 120.00                          | .079923           | .079923   | .025783   | .052853                         | .512170                      |
| 125.00                          | .074267           | .074267   | .027631   | .050949                         | .452681                      |
| 130.00                          | .069847           | .069847   | .030085   | .049966                         | .397897                      |
| 135.00                          | .066450           | .066450   | .032853   | .049451                         | .338331                      |
| 140.00                          | .063871           | .063871   | .036051   | .049961                         | .278424                      |
| 145.00                          | .061980           | .061980   | .039554   | .050768                         | .220844                      |
| 150.00                          | .060645           | .060645   | .043310   | .051978                         | .166751                      |
| 155.00                          | .059591           | .059591   | .047348   | .053469                         | .114487                      |
| 160.00                          | .058381           | .058381   | .051452   | .054916                         | .063081                      |
| 165.00                          | .056910           | .056910   | .054905   | .055907                         | .017932                      |
| 170.00                          | .054562           | .054562   | .054827   | .054694                         | -.002421                     |
| 175.00                          | .054141           | .054141   | .054337   | .054239                         | -.001614                     |
| 180.00                          | .055240           | .055240   | .055240   | .055240                         | .000000                      |

TABLE 17. INTENSITY AND POLARIZATION FOR ICE I ( $1 \leq \alpha \leq 10$ )

| MATERIALS PRESENT ARE<br>ICE H=<br>$1 \leq \alpha \leq 10$ |                   | 1.33000   | - .050001 | NO OF PARTICLES PER UNIT VOL. = $4.995000 \times 10^{12}$ |              |  |
|--|-------------------|-----------|-----------|---|--------------|--|
| THETA  | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY   | POLARIZATION |  |
| .00  | 13.414927         | 13.414927 | 13.414927 | 13.414927   | .000000      |  |
| 5.00   | 12.247744         | 12.247744 | 12.247744 | 12.247744   | .000205      |  |
| 10.00  | 9.44562           | 9.44562   | 9.44562   | 9.44562   | .000979      |  |
| 15.00  | 6.518566          | 6.518566  | 6.518566  | 6.518566  | .003383      |  |
| 20.00  | 4.362317          | 4.362317  | 4.362317  | 4.362317  | .010189      |  |
| 25.00  | 3.040660          | 3.040660  | 3.040660  | 3.040660  | .023618      |  |
| 30.00  | 2.200277          | 2.200277  | 2.200277  | 2.200277  | .042194      |  |
| 35.00  | 1.606941          | 1.606941  | 1.606941  | 1.606941  | .064733      |  |
| 40.00  | 1.192427          | 1.192427  | 1.192427  | 1.192427  | .093545      |  |
| 45.00  | .911736           | .911736   | .911736   | .911736   | .130036      |  |
| 50.00  | .710171           | .710171   | .710171   | .710171   | .172007      |  |
| 55.00  | .557770           | .557770   | .557770   | .557770   | .218297      |  |
| 60.00  | .445458           | .445458   | .445458   | .445458   | .270421      |  |
| 65.00  | .363052           | .363052   | .363052   | .363052   | .327804      |  |
| 70.00  | .299103           | .299103   | .299103   | .299103   | .386571      |  |
| 75.00  | .248365           | .248365   | .248365   | .248365   | .444193      |  |
| 80.00  | .209207           | .209207   | .209207   | .209207   | .500235      |  |
| 85.00  | .178834           | .178834   | .178834   | .178834   | .551623      |  |
| 90.00  | .154142           | .154142   | .154142   | .154142   | .592344      |  |
| 95.00  | .133888           | .133888   | .133888   | .133888   | .618774      |  |
| 100.00   | .117839           | .117839   | .117839   | .117839   | .630945      |  |
| 105.00   | .105084           | .105084   | .105084   | .105084   | .628720      |  |
| 110.00   | .094444           | .094444   | .094444   | .094444   | .609781      |  |
| 115.00   | .085624           | .085624   | .085624   | .085624   | .573115      |  |
| 120.00   | .078708           | .078708   | .078708   | .078708   | .524253      |  |
| 125.00   | .073224           | .073224   | .073224   | .073224   | .470859      |  |
| 130.00   | .068726           | .068726   | .068726   | .068726   | .413337      |  |
| 135.00   | .065262           | .065262   | .065262   | .065262   | .349836      |  |
| 140.00   | .062602           | .062602   | .062602   | .062602   | .285347      |  |
| 145.00   | .060379           | .060379   | .060379   | .060379   | .225436      |  |
| 150.00   | .058985           | .058985   | .058985   | .058985   | .169860      |  |
| 155.00   | .058388           | .058388   | .058388   | .058388   | .116553      |  |
| 160.00   | .056974           | .056974   | .056974   | .056974   | .064997      |  |
| 165.00   | .054130           | .054130   | .054130   | .054130   | .020213      |  |
| 170.00   | .052191           | .052191   | .052191   | .052191   | -.004283     |  |
| 175.00   | .052742           | .052742   | .052742   | .052742   | -.004510     |  |
| 180.00   | .053585           | .053585   | .053585   | .053585   | .000000      |  |

TABLE 16. INTENSITY AND POLARIZATION FOR ICE I ( $1 \leq \alpha \leq 5$ )

| MATERIALS PRESENT ARE<br>ICE H= |                   | 1.33000   | -.0500001 | NO OF PARTICLES PER UNIT VOL.= | 4.960000 x 10 <sup>12</sup> |           |              |
|---------------------------------|-------------------|-----------|-----------|--------------------------------|-----------------------------|-----------|--------------|
| THETA                           | GAUSSIAN INTEGRAL | X11 INTEN |           | X12 INTEN                      |                             | INTENSITY | POLARIZATION |
|                                 |                   | X11 INTEN | X12 INTEN | X11 INTEN                      | X12 INTEN                   |           |              |
| 0.00                            | 4.665650          | 4.665650  | 4.665650  | 4.665650                       | 4.665650                    | 4.865650  | .000000      |
| 5.00                            | 4.734625          | 4.734625  | 4.734625  | 4.734625                       | 4.734625                    | 4.725996  | .001826      |
| 10.00                           | 4.364132          | 4.364132  | 4.364132  | 4.364132                       | 4.364132                    | 4.332550  | .007290      |
| 15.00                           | 3.815696          | 3.815696  | 3.815696  | 3.815696                       | 3.815696                    | 3.754300  | .016353      |
| 20.00                           | 3.173358          | 3.173358  | 3.173358  | 3.173358                       | 3.173358                    | 3.083986  | .028979      |
| 25.00                           | 2.522855          | 2.522855  | 2.522855  | 2.522855                       | 2.522855                    | 2.413785  | .045186      |
| 30.00                           | 1.933230          | 1.933230  | 1.933230  | 1.933230                       | 1.933230                    | 1.814944  | .065173      |
| 35.00                           | 1.446042          | 1.446042  | 1.446042  | 1.446042                       | 1.446042                    | 1.327231  | .089518      |
| 40.00                           | 1.073954          | 1.073954  | 1.073954  | 1.073954                       | 1.073954                    | .959433   | .119363      |
| 45.00                           | .806977           | .806977   | .806977   | .806977                        | .806977                     | .677891   | .156308      |
| 50.00                           | .622549           | .622549   | .622549   | .622549                        | .622549                     | .518065   | .201680      |
| 55.00                           | .495352           | .495352   | .495352   | .495352                        | .495352                     | .394537   | .255525      |
| 60.00                           | .404088           | .404088   | .404088   | .404088                        | .404088                     | .307003   | .316236      |
| 65.00                           | .334328           | .334328   | .334328   | .334328                        | .334328                     | .242066   | .381143      |
| 70.00                           | .278141           | .278141   | .278141   | .278141                        | .278141                     | .192188   | .447236      |
| 75.00                           | .232021           | .232021   | .232021   | .232021                        | .232021                     | .153506   | .511473      |
| 80.00                           | .194570           | .194570   | .194570   | .194570                        | .194570                     | .123862   | .570865      |
| 85.00                           | .164857           | .164857   | .164857   | .164857                        | .164857                     | .101593   | .622715      |
| 90.00                           | .141694           | .141694   | .141694   | .141694                        | .141694                     | .085109   | .664864      |
| 95.00                           | .123634           | .123634   | .123634   | .123634                        | .123634                     | .072917   | .695539      |
| 100.00                          | .109274           | .109274   | .109274   | .109274                        | .109274                     | .063801   | .712727      |
| 105.00                          | .097535           | .097535   | .097535   | .097535                        | .097535                     | .056913   | .713754      |
| 110.00                          | .087747           | .087747   | .087747   | .087747                        | .087747                     | .051744   | .695793      |
| 115.00                          | .079552           | .079552   | .079552   | .079552                        | .079552                     | .048000   | .657353      |
| 120.00                          | .072723           | .072723   | .072723   | .072723                        | .072723                     | .045458   | .599792      |
| 125.00                          | .067028           | .067028   | .067028   | .067028                        | .067028                     | .043882   | .527481      |
| 130.00                          | .062202           | .062202   | .062202   | .062202                        | .062202                     | .043007   | .446302      |
| 135.00                          | .058010           | .058010   | .058010   | .058010                        | .058010                     | .042598   | .361823      |
| 140.00                          | .054350           | .054350   | .054350   | .054350                        | .054350                     | .042506   | .278649      |
| 145.00                          | .051295           | .051295   | .051295   | .051295                        | .051295                     | .042710   | .200987      |
| 150.00                          | .049047           | .049047   | .049047   | .049047                        | .049047                     | .043282   | .133206      |
| 155.00                          | .047809           | .047809   | .047809   | .047809                        | .047809                     | .044297   | .079279      |
| 160.00                          | .047626           | .047626   | .047626   | .047626                        | .047626                     | .045740   | .041237      |
| 165.00                          | .048292           | .048292   | .048292   | .048292                        | .048292                     | .047435   | .018052      |
| 170.00                          | .049365           | .049365   | .049365   | .049365                        | .049365                     | .049063   | .006161      |
| 175.00                          | .050307           | .050307   | .050307   | .050307                        | .050307                     | .050245   | .001240      |
| 180.00                          | .050678           | .050678   | .050678   | .050678                        | .050678                     | .050678   | .000000      |

TABLE 15. INTENSITY AND POLARIZATION FOR TITANITE ( $1 \leq \alpha \leq 25$ )

| MATERIALS PRESENT ARE<br>TANIUM M= |                   | 2.00000   | 1000001   | NO OF PARTICLES PER UNIT VOL. = |              | 4.999680 x 10 <sup>-12</sup> |
|------------------------------------|-------------------|-----------|-----------|---------------------------------|--------------|------------------------------|
| THETA                              | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY                       | POLARIZATION |                              |
| 5.00                               | 31.588165         | 31.588165 | 31.588165 | 31.588165                       | .000000      |                              |
| 10.00                              | 23.081693         | 23.081693 | 23.081693 | 23.081693                       | -.001683     |                              |
| 15.00                              | 14.365502         | 14.365502 | 14.365502 | 14.365502                       | -.002907     |                              |
| 20.00                              | 10.611498         | 10.611498 | 10.611498 | 10.611498                       | -.006453     |                              |
| 25.00                              | 8.402916          | 8.402916  | 8.402916  | 8.402916                        | -.008804     |                              |
| 30.00                              | 6.903054          | 6.903054  | 6.903054  | 6.903054                        | -.009440     |                              |
| 35.00                              | 5.797631          | 5.797631  | 5.797631  | 5.797631                        | -.007632     |                              |
| 40.00                              | 4.923993          | 4.923993  | 4.923993  | 4.923993                        | -.005449     |                              |
| 45.00                              | 4.190758          | 4.190758  | 4.190758  | 4.190758                        | -.006682     |                              |
| 50.00                              | 3.567949          | 3.567949  | 3.567949  | 3.567949                        | -.010225     |                              |
| 55.00                              | 3.052888          | 3.052888  | 3.052888  | 3.052888                        | -.013966     |                              |
| 60.00                              | 2.627703          | 2.627703  | 2.627703  | 2.627703                        | -.017615     |                              |
| 65.00                              | 2.253518          | 2.253518  | 2.253518  | 2.253518                        | -.023832     |                              |
| 70.00                              | 1.933255          | 1.933255  | 1.933255  | 1.933255                        | -.031711     |                              |
| 75.00                              | 1.666008          | 1.666008  | 1.666008  | 1.666008                        | -.042033     |                              |
| 80.00                              | 1.450196          | 1.450196  | 1.450196  | 1.450196                        | -.052734     |                              |
| 85.00                              | 1.271454          | 1.271454  | 1.271454  | 1.271454                        | -.065962     |                              |
| 90.00                              | 1.114034          | 1.114034  | 1.114034  | 1.114034                        | -.081566     |                              |
| 95.00                              | .981440           | .981440   | .981440   | .981440                         | -.096807     |                              |
| 100.00                             | .867373           | .867373   | .867373   | .867373                         | -.118167     |                              |
| 105.00                             | .765182           | .765182   | .765182   | .765182                         | -.143958     |                              |
| 110.00                             | .688377           | .688377   | .688377   | .688377                         | -.162632     |                              |
| 115.00                             | .632351           | .632351   | .632351   | .632351                         | -.174207     |                              |
| 120.00                             | .591907           | .591907   | .591907   | .591907                         | -.182411     |                              |
| 125.00                             | .552366           | .552366   | .552366   | .552366                         | -.196373     |                              |
| 130.00                             | .506044           | .506044   | .506044   | .506044                         | -.214384     |                              |
| 135.00                             | .477607           | .477607   | .477607   | .477607                         | -.218451     |                              |
| 140.00                             | .475747           | .475747   | .475747   | .475747                         | -.197676     |                              |
| 145.00                             | .511121           | .511121   | .511121   | .511121                         | -.146151     |                              |
| 150.00                             | .529943           | .529943   | .529943   | .529943                         | -.074667     |                              |
| 155.00                             | .671271           | .671271   | .671271   | .671271                         | -.015831     |                              |
| 160.00                             | .809291           | .809291   | .809291   | .809291                         | .014018      |                              |
| 165.00                             | 1.033671          | 1.033671  | 1.033671  | 1.033671                        | .026933      |                              |
| 170.00                             | 1.385824          | 1.385824  | 1.385824  | 1.385824                        | .023253      |                              |
| 175.00                             | 1.889471          | 1.889471  | 1.889471  | 1.889471                        | .016026      |                              |
| 180.00                             | 2.551696          | 2.551696  | 2.551696  | 2.551696                        | .006368      |                              |
|                                    | 2.964715          | 2.964715  | 2.964715  | 2.964715                        | .000000      |                              |

TABLE 14. INTENSITY AND POLARIZATION FOR TITANITE ( $1 \leq \alpha \leq 20$ )

| MATERIALS PRESENT ARE |                   | 2.000000  | .000001   | NO OF PARTICLES PER UNIT VOL.= |              | 4.999375 x 10 <sup>-12</sup> |
|-----------------------|-------------------|-----------|-----------|--------------------------------|--------------|------------------------------|
| TANUM H=              |                   |           |           |                                |              |                              |
| 150520                |                   |           |           |                                |              |                              |
| THETA                 | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY                      | POLARIZATION |                              |
| 0.00                  | 26.447442         | 26.447442 | 26.447442 | 26.447442                      | .000000      |                              |
| 5.00                  | 21.369939         | 41.411667 | 41.411667 | 21.369939                      | -.000976     |                              |
| 10.00                 | 14.229236         | 14.231796 | 14.231796 | 17.230516                      | -.000040     |                              |
| 15.00                 | 10.580881         | 10.517591 | 10.517591 | 10.577736                      | .003142      |                              |
| 20.00                 | 8.429932          | 8.429932  | 8.365049  | 8.407490                       | .002669      |                              |
| 25.00                 | 6.943070          | 6.943070  | 6.955074  | 6.949072                       | -.000804     |                              |
| 30.00                 | 5.809017          | 5.809017  | 5.864806  | 5.836711                       | -.004779     |                              |
| 35.00                 | 4.901494          | 4.901494  | 4.969394  | 4.935439                       | -.006876     |                              |
| 40.00                 | 4.163624          | 4.163624  | 4.222081  | 4.172852                       | -.006971     |                              |
| 45.00                 | 3.547352          | 3.547352  | 3.606224  | 3.576788                       | -.008230     |                              |
| 50.00                 | 3.034414          | 3.034414  | 3.103322  | 3.068868                       | -.011227     |                              |
| 55.00                 | 2.597689          | 2.597689  | 2.685633  | 2.643161                       | -.017204     |                              |
| 60.00                 | 2.229620          | 2.229620  | 2.339095  | 2.284357                       | -.023462     |                              |
| 65.00                 | 1.917941          | 1.917941  | 2.045078  | 1.981509                       | -.032081     |                              |
| 70.00                 | 1.657330          | 1.657330  | 1.800542  | 1.728935                       | -.041416     |                              |
| 75.00                 | 1.437457          | 1.437457  | 1.600046  | 1.518751                       | -.053527     |                              |
| 80.00                 | 1.247267          | 1.247267  | 1.436379  | 1.342833                       | -.067883     |                              |
| 85.00                 | 1.093458          | 1.093458  | 1.298973  | 1.178418                       | -.084590     |                              |
| 90.00                 | .964505           | .964505   | 1.182339  | 1.073424                       | -.101465     |                              |
| 95.00                 | .854595           | .854595   | 1.097929  | .971262                        | -.120119     |                              |
| 100.00                | .756773           | .756773   | 1.012303  | .885538                        | -.143150     |                              |
| 105.00                | .678369           | .678369   | .952860   | .815825                        | -.168282     |                              |
| 110.00                | .614544           | .614544   | .903474   | .759034                        | -.190294     |                              |
| 115.00                | .565698           | .565698   | .858295   | .711597                        | -.205476     |                              |
| 120.00                | .526171           | .526171   | .818292   | .672231                        | -.217277     |                              |
| 125.00                | .496739           | .496739   | .782976   | .639858                        | -.223672     |                              |
| 130.00                | .479474           | .479474   | .752739   | .618107                        | -.221768     |                              |
| 135.00                | .478474           | .478474   | .722821   | .606847                        | -.203403     |                              |
| 140.00                | .497131           | .497131   | .696456   | .598793                        | -.168497     |                              |
| 145.00                | .539462           | .539462   | .673134   | .610478                        | -.124873     |                              |
| 150.00                | .626296           | .626296   | .733088   | .675892                        | -.078554     |                              |
| 155.00                | .763105           | .763105   | .827397   | .805431                        | -.027502     |                              |
| 160.00                | 1.018699          | .994378   | .994378   | 1.006338                       | .012082      |                              |
| 165.00                | 1.350551          | 1.271420  | 1.271420  | 1.310786                       | .030180      |                              |
| 170.00                | 1.803861          | 1.722129  | 1.722129  | 1.782955                       | .023150      |                              |
| 175.00                | 2.372318          | 2.334805  | 2.334805  | 2.353583                       | .007469      |                              |
| 180.00                | 2.886780          | 2.886780  | 2.886780  | 2.886780                       | .000000      |                              |

TABLE 13. INTENSITY AND POLARIZATION FOR TITANITE ( $1 \leq \alpha \leq 15$ )

| MATERIALS PRESENT ARE |  | 2.00000           | 0.000001  | NO OF PARTICLES PER UNIT VOL.= |           | 4.988518 x 10 <sup>-12</sup> |
|-----------------------|--|-------------------|-----------|--------------------------------|-----------|------------------------------|
| TANUM N=              |  | 154515            |           |                                |           |                              |
| THETA                 |  | GAUSSIAN INTEGRAL |           | X12 INTEN                      | INTENSITY | POLARIZATION                 |
|                       |  | X11 INTEN         |           |                                |           |                              |
| 0.00                  |  | 21.630124         | 21.630124 | 21.630124                      | 21.630124 | 0.000000                     |
| 5.00                  |  | 18.974776         | 19.024671 | 19.024671                      | 18.999724 | -0.001313                    |
| 10.00                 |  | 14.001527         | 14.064927 | 14.064927                      | 14.040227 | -0.001759                    |
| 15.00                 |  | 10.448276         | 10.442050 | 10.442050                      | 10.445163 | 0.000298                     |
| 20.00                 |  | 8.335183          | 8.370352  | 8.370352                       | 8.352768  | -0.002105                    |
| 25.00                 |  | 6.851205          | 6.960694  | 6.960694                       | 6.905952  | -0.007427                    |
| 30.00                 |  | 5.740139          | 5.864273  | 5.864273                       | 5.802206  | -0.010697                    |
| 35.00                 |  | 4.852645          | 4.959576  | 4.959576                       | 4.906111  | -0.010898                    |
| 40.00                 |  | 4.119050          | 4.204027  | 4.204027                       | 4.161538  | -0.010210                    |
| 45.00                 |  | 3.506979          | 3.581246  | 3.581246                       | 3.544112  | -0.010478                    |
| 50.00                 |  | 2.995908          | 3.070605  | 3.070605                       | 3.033256  | -0.012313                    |
| 55.00                 |  | 2.584168          | 2.655967  | 2.655967                       | 2.620067  | -0.013702                    |
| 60.00                 |  | 2.231374          | 2.317404  | 2.317404                       | 2.274389  | -0.018913                    |
| 65.00                 |  | 1.917464          | 2.032340  | 2.032340                       | 1.974902  | -0.029084                    |
| 70.00                 |  | 1.650382          | 1.783409  | 1.783409                       | 1.716895  | -0.038740                    |
| 75.00                 |  | 1.426824          | 1.576229  | 1.576229                       | 1.501527  | -0.049751                    |
| 80.00                 |  | 1.237513          | 1.412902  | 1.412902                       | 1.325207  | -0.066174                    |
| 85.00                 |  | 1.087048          | 1.282840  | 1.282840                       | 1.184964  | -0.082632                    |
| 90.00                 |  | .959929           | 1.172490  | 1.172490                       | 1.066210  | -0.099681                    |
| 95.00                 |  | .851598           | 1.071488  | 1.071488                       | .961543   | -0.114342                    |
| 100.00                |  | .760327           | .943712   | .943712                        | .877019   | -0.133056                    |
| 105.00                |  | .685366           | .938572   | .938572                        | .811979   | -0.155907                    |
| 110.00                |  | .617590           | .897309   | .897309                        | .757450   | -0.184645                    |
| 115.00                |  | .564082           | .850897   | .850897                        | .708489   | -0.201001                    |
| 120.00                |  | .525245           | .803427   | .803427                        | .664336   | -0.209368                    |
| 125.00                |  | .491876           | .771992   | .771992                        | .631934   | -0.221634                    |
| 130.00                |  | .475987           | .751094   | .751094                        | .613541   | -0.224196                    |
| 135.00                |  | .476978           | .727672   | .727672                        | .602325   | -0.208105                    |
| 140.00                |  | .482466           | .692622   | .692622                        | .589364   | -0.181379                    |
| 145.00                |  | .527159           | .687241   | .687241                        | .607200   | -0.131420                    |
| 150.00                |  | .625261           | .728449   | .728449                        | .676855   | -0.076227                    |
| 155.00                |  | .781551           | .834861   | .834861                        | .808206   | -0.032981                    |
| 160.00                |  | 1.012955          | 1.004089  | 1.004089                       | 1.008522  | 0.043396                     |
| 165.00                |  | 1.332182          | 1.267100  | 1.267100                       | 1.299641  | 0.25038                      |
| 170.00                |  | 1.755465          | 1.673450  | 1.673450                       | 1.714457  | 0.23919                      |
| 175.00                |  | 2.204017          | 2.168440  | 2.168440                       | 2.186629  | 0.08137                      |
| 180.00                |  | 2.421924          | 2.421924  | 2.421924                       | 2.421924  | 0.000000                     |

TABLE 12. INTENSITY AND POLARIZATION FOR TITANITE ( $1 \leq \alpha \leq 10$ )

| MATERIALS PRESENT ARE<br>TANIUM $M =$<br>$15 \leq \alpha \leq 10$ |                   |  |  | •GJ0001   |           | NO OF PARTICLES PER UNIT VOL. = |  | 4.985000 x 10 <sup>-12</sup> |          |
|---|-------------------|--|--|-----------|-----------|---------------------------------|--|------------------------------|----------|
| THETA   | GAUSSIAN INTEGRAL |  |  | 412 INTEN | Intensity | POLARIZATION                    |  |                              |          |
|   | 411 INTEN         |  |  |           |           |                                 |  |                              |          |
| •00   | 16.216707         |  |  | 16.216707 | 16.216707 |                                 |  |                              | •000000  |
| 5.00  | 15.200997         |  |  | 15.240303 | 15.220091 |                                 |  |                              | •0001294 |
| 10.00   | 12.780204         |  |  | 12.891531 | 12.835907 |                                 |  |                              | •0004335 |
| 15.00   | 10.177756         |  |  | 10.323959 | 10.251804 |                                 |  |                              | •0007033 |
| 20.00   | 8.153430          |  |  | 8.281934  | 8.217082  |                                 |  |                              | •0007819 |
| 25.00   | 6.730774          |  |  | 6.813771  | 6.761378  |                                 |  |                              | •0007461 |
| 30.00   | 5.662121          |  |  | 5.752072  | 5.707297  |                                 |  |                              | •0007881 |
| 35.00   | 4.763250          |  |  | 4.870743  | 4.829997  |                                 |  |                              | •0008078 |
| 40.00   | 4.051598          |  |  | 4.140211  | 4.098905  |                                 |  |                              | •0111541 |
| 45.00   | 3.455970          |  |  | 3.540349  | 3.490170  |                                 |  |                              | •0012058 |
| 50.00   | 2.960978          |  |  | 3.039038  | 3.003068  |                                 |  |                              | •0011998 |
| 55.00   | 2.549311          |  |  | 2.521603  | 2.503707  |                                 |  |                              | •0013802 |
| 60.00   | 2.169310          |  |  | 2.275128  | 2.232073  |                                 |  |                              | •0019289 |
| 65.00   | 1.863548          |  |  | 1.980977  | 1.939273  |                                 |  |                              | •0272230 |
| 70.00   | 1.626390          |  |  | 1.750470  | 1.683060  |                                 |  |                              | •0036705 |
| 75.00   | 1.407162          |  |  | 1.552749  | 1.474755  |                                 |  |                              | •0049186 |
| 80.00   | 1.220404          |  |  | 1.389909  | 1.307080  |                                 |  |                              | •0004554 |
| 85.00   | 1.060802          |  |  | 1.252330  | 1.157610  |                                 |  |                              | •0079905 |
| 90.00   | .940117           |  |  | 1.134431  | 1.037734  |                                 |  |                              | •0096028 |
| 95.00   | .833348           |  |  | 1.047217  | .941532   |                                 |  |                              | •0114903 |
| 100.00  | .743015           |  |  | .970362   | .863238   |                                 |  |                              | •0135571 |
| 105.00  | .667118           |  |  | .918337   | .792727   |                                 |  |                              | •0138452 |
| 110.00  | .602108           |  |  | .871301   | .736732   |                                 |  |                              | •0162052 |
| 115.00  | .550173           |  |  | .828173   | .689173   |                                 |  |                              | •0201091 |
| 120.00  | .509203           |  |  | .787370   | .642200   |                                 |  |                              | •0214541 |
| 125.00  | .477771           |  |  | .752584   | .615173   |                                 |  |                              | •0223360 |
| 130.00  | .456573           |  |  | .719900   | .593276   |                                 |  |                              | •0221770 |
| 135.00  | .433627           |  |  | .689386   | .571357   |                                 |  |                              | •0200053 |
| 140.00  | .408810           |  |  | .669921   | .550737   |                                 |  |                              | •0176010 |
| 145.00  | .516804           |  |  | .649342   | .529103   |                                 |  |                              | •0128543 |
| 150.00  | .600472           |  |  | .701277   | .601860   |                                 |  |                              | •0070836 |
| 155.00  | .756224           |  |  | .795173   | .775093   |                                 |  |                              | •0025107 |
| 160.00  | .977724           |  |  | .972370   | .976047   |                                 |  |                              | •003767  |
| 165.00  | 1.292493          |  |  | 1.273163  | 1.273163  |                                 |  |                              | •017577  |
| 170.00  | 1.674481          |  |  | 1.624942  | 1.647712  |                                 |  |                              | •015014  |
| 175.00  | 2.024620          |  |  | 2.004698  | 2.014634  |                                 |  |                              | •004957  |
| 180.00  | 2.172101          |  |  | 2.172101  | 2.172101  |                                 |  |                              | •000000  |

TABLE 11. INTENSITY AND POLARIZATION FOR TITANITE ( $1 \leq \alpha \leq 5$ )

| MATERIALS PRESENT ARE |  | 2.00000           |           | .000001   |           | NO OF PARTICLES PER UNIT VOL.= 4.960000 x 10 <sup>12</sup> |              |
|-----------------------|--|-------------------|-----------|-----------|-----------|--|--------------|
| TANUM No              |  | 16665             |           |           |           |  |              |
| THETA                 |  | GAUSSIAN INTEGRAL |           | X12 INTEN | X12 INTEN | INTENSITY  | POLARIZATION |
|                       |  | X11 INTEN         | X12 INTEN |           |           |  |              |
| 5.00                  |  | 9.850820          | 9.850820  | 9.850820  | 9.850820  | 9.850820   | .000000      |
| 10.00                 |  | 9.639068          | 9.641397  | 9.641397  | 9.641397  | 9.640233   | .000121      |
| 15.00                 |  | 9.048387          | 9.057762  | 9.057762  | 9.057762  | 9.053074   | .000518      |
| 20.00                 |  | 8.194101          | 8.214886  | 8.214886  | 8.214886  | 8.204493   | .001267      |
| 25.00                 |  | 7.217797          | 7.252708  | 7.252708  | 7.252708  | 7.235252   | .002413      |
| 30.00                 |  | 6.241306          | 6.290148  | 6.290148  | 6.290148  | 6.265727   | .003898      |
| 35.00                 |  | 5.340968          | 5.400701  | 5.400701  | 5.400701  | 5.370835   | .005561      |
| 40.00                 |  | 4.548187          | 4.614590  | 4.614590  | 4.614590  | 4.581388   | .007247      |
| 45.00                 |  | 3.866204          | 3.935934  | 3.935934  | 3.935934  | 3.901069   | .008937      |
| 50.00                 |  | 3.287457          | 3.359020  | 3.359020  | 3.359020  | 3.323239   | .010767      |
| 55.00                 |  | 2.802216          | 2.875483  | 2.875483  | 2.875483  | 2.838849   | .012904      |
| 60.00                 |  | 2.399351          | 2.474681  | 2.474681  | 2.474681  | 2.437016   | .015455      |
| 65.00                 |  | 2.065480          | 2.143648  | 2.143648  | 2.143648  | 2.104564   | .018571      |
| 70.00                 |  | 1.786545          | 1.869555  | 1.869555  | 1.869555  | 1.828050   | .022704      |
| 75.00                 |  | 1.550865          | 1.642539  | 1.642539  | 1.642539  | 1.596702   | .028707      |
| 80.00                 |  | 1.350494          | 1.455852  | 1.455852  | 1.455852  | 1.403173   | .037543      |
| 85.00                 |  | 1.179892          | 1.303574  | 1.303574  | 1.303574  | 1.241733   | .049802      |
| 90.00                 |  | 1.034015          | 1.178993  | 1.178993  | 1.178993  | 1.106504   | .065512      |
| 95.00                 |  | .908262           | 1.075657  | 1.075657  | 1.075657  | .991959  | .084376      |
| 100.00                |  | .799972           | .989575   | .989575   | .989575   | .894773  | .105950      |
| 105.00                |  | .708969           | .919408   | .919408   | .919408   | .814189  | .129232      |
| 110.00                |  | .635596           | .863896   | .863896   | .863896   | .749746  | .152252      |
| 115.00                |  | .577901           | .819326   | .819326   | .819326   | .698614  | .172788      |
| 120.00                |  | .531194           | .780269   | .780269   | .780269   | .655732  | .189921      |
| 125.00                |  | .491050           | .743151   | .743151   | .743151   | .617101  | .204264      |
| 130.00                |  | .457082           | .708565   | .708565   | .708565   | .582823  | .215746      |
| 135.00                |  | .433712           | .672225   | .672225   | .672225   | .556469  | .220599      |
| 140.00                |  | .427378           | .655892   | .655892   | .655892   | .541635  | .210948      |
| 145.00                |  | .443742           | .637286   | .637286   | .637286   | .540514  | .179037      |
| 150.00                |  | .488602           | .627000   | .627000   | .627000   | .557801  | .124057      |
| 155.00                |  | .571282           | .641922   | .641922   | .641922   | .606602  | .058226      |
| 160.00                |  | .704313           | .711184   | .711184   | .711184   | .707749  | .004854      |
| 165.00                |  | .894531           | .859619   | .859619   | .859619   | .877075  | .019903      |
| 170.00                |  | 1.128865          | 1.083193  | 1.083193  | 1.083193  | 1.106029   | .020647      |
| 175.00                |  | 1.366218          | 1.334860  | 1.334860  | 1.334860  | 1.350639   | .011609      |
| 180.00                |  | 1.546092          | 1.536253  | 1.536253  | 1.536253  | 1.541172   | .003192      |
|                       |  | 1.613472          | 1.613472  | 1.613472  | 1.613472  | 1.613472   | .000000      |



TABLE 10. INTENSITY AND POLARIZATION FOR QUARTZ ( $1 \leq \alpha \leq 25$ )

| MATERIALS PRESENT ARE<br>QUARTZ $\alpha =$<br>$15 \leq \alpha \leq 25$ |                   | 1.55000   | .000001   | NO OF PARTICLES PER UNIT VOL. = | 4.999680 $\times 10^{-12}$ |
|--|-------------------|-----------|-----------|---------------------------------|----------------------------|
| THETA  | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY                       | POLARIZATION               |
| .00  | 31.999757         | 31.999757 | 31.999757 | 31.999757                       | .000000                    |
| 5.00   | 23.269281         | 23.351727 | 23.351727 | 23.320504                       | -.001339                   |
| 10.00  | 14.344660         | 14.392363 | 14.392363 | 14.368512                       | -.001660                   |
| 15.00  | 10.280399         | 10.335531 | 10.335531 | 10.307965                       | -.002674                   |
| 20.00  | 7.782757          | 7.807715  | 7.807715  | 7.795236                        | -.001601                   |
| 25.00  | 6.049484          | 6.027970  | 6.027970  | 6.038727                        | .001761                    |
| 30.00  | 4.763537          | 4.708256  | 4.708256  | 4.735646                        | .005784                    |
| 35.00  | 3.786728          | 3.690453  | 3.690453  | 3.728590                        | .010228                    |
| 40.00  | 2.999393          | 2.899100  | 2.899100  | 2.949276                        | .016993                    |
| 45.00  | 2.405972          | 2.282660  | 2.282660  | 2.344316                        | .026300                    |
| 50.00  | 1.946921          | 1.801627  | 1.801627  | 1.874274                        | .038760                    |
| 55.00  | 1.579690          | 1.426327  | 1.426327  | 1.503108                        | .051082                    |
| 60.00  | 1.249514          | 1.134811  | 1.134811  | 1.214983                        | .065970                    |
| 65.00  | 1.070954          | .908052   | .908052   | .989503                         | .082315                    |
| 70.00  | .890217           | .730826   | .730826   | .818521                         | .098326                    |
| 75.00  | .747446           | .595771   | .595771   | .671609                         | .112920                    |
| 80.00  | .633218           | .490839   | .490839   | .562029                         | .126605                    |
| 85.00  | .538456           | .409878   | .409878   | .474167                         | .135583                    |
| 90.00  | .463746           | .351219   | .351219   | .407482                         | .138076                    |
| 95.00  | .402641           | .303904   | .303904   | .353273                         | .139746                    |
| 100.00   | .352896           | .273022   | .273022   | .312959                         | .127611                    |
| 105.00   | .312922           | .250697   | .250697   | .281809                         | .110403                    |
| 110.00   | .281015           | .235841   | .235841   | .258428                         | .087401                    |
| 115.00   | .256280           | .231768   | .231768   | .244027                         | .050238                    |
| 120.00   | .235304           | .232238   | .232238   | .233771                         | .006557                    |
| 125.00   | .220504           | .230111   | .230111   | .230111                         | -.041749                   |
| 130.00   | .210183           | .225814   | .225814   | .232998                         | -.097919                   |
| 135.00   | .203107           | .229571   | .229571   | .241339                         | -.158415                   |
| 140.00   | .201429           | .231480   | .231480   | .257455                         | -.217614                   |
| 145.00   | .203391           | .239761   | .239761   | .281576                         | -.277670                   |
| 150.00   | .214234           | .248124   | .248124   | .316184                         | -.322406                   |
| 155.00   | .233635           | .267042   | .267042   | .360338                         | -.351624                   |
| 160.00   | .262758           | .294862   | .294862   | .405810                         | -.352510                   |
| 165.00   | .327799           | .360292   | .360292   | .465370                         | -.295617                   |
| 170.00   | .502738           | .687232   | .687232   | .595235                         | -.155396                   |
| 175.00   | .664184           | .780948   | .780948   | .722566                         | -.080748                   |
| 180.00   | .858950           | .858950   | .858950   | .858950                         | .000000                    |

TABLE 9. INTENSITY AND POLARIZATION FOR QUARTZ ( $1 \leq \alpha \leq 20$ )

| MATERIALS PRESENT ARE |                   | 1.55000   |           | .000001   |           | NO OF PARTICLES PER UNIT VOL. = |  | 4.999375 x 10 <sup>-12</sup> |  |
|-----------------------|-------------------|-----------|-----------|-----------|-----------|---------------------------------|--|------------------------------|--|
| QUARTZ M =            |                   | 1.55000   |           | .000001   |           | NO OF PARTICLES PER UNIT VOL. = |  | 4.999375 x 10 <sup>-12</sup> |  |
| 1 ≤ α ≤ 20            |                   | 1.55000   |           | .000001   |           | NO OF PARTICLES PER UNIT VOL. = |  | 4.999375 x 10 <sup>-12</sup> |  |
| THETA                 | GAUSSIAN INTEGRAL | XII INTEN | XII INTEN | XII INTEN | INTENSITY | POLARIZATION                    |  |                              |  |
| 0.00                  | 27.089007         | 27.089007 | 27.089007 | 27.089007 | 27.089007 | .000000                         |  |                              |  |
| 5.00                  | 21.753678         | 21.753678 | 21.753678 | 21.753678 | 21.753678 | -.001370                        |  |                              |  |
| 10.00                 | 14.221964         | 14.221964 | 14.221964 | 14.221964 | 14.221964 | -.002752                        |  |                              |  |
| 15.00                 | 10.210756         | 10.210756 | 10.210756 | 10.210756 | 10.210756 | -.002598                        |  |                              |  |
| 20.00                 | 7.730755          | 7.730755  | 7.730755  | 7.730755  | 7.730755  | -.001837                        |  |                              |  |
| 25.00                 | 6.017351          | 6.017351  | 6.017351  | 6.017351  | 6.017351  | -.001589                        |  |                              |  |
| 30.00                 | 4.717549          | 4.717549  | 4.717549  | 4.717549  | 4.717549  | .005007                         |  |                              |  |
| 35.00                 | 3.744622          | 3.744622  | 3.744622  | 3.744622  | 3.744622  | .011195                         |  |                              |  |
| 40.00                 | 2.978855          | 2.978855  | 2.978855  | 2.978855  | 2.978855  | .017973                         |  |                              |  |
| 45.00                 | 2.391374          | 2.391374  | 2.391374  | 2.391374  | 2.391374  | .027763                         |  |                              |  |
| 50.00                 | 1.930502          | 1.930502  | 1.930502  | 1.930502  | 1.930502  | .039024                         |  |                              |  |
| 55.00                 | 1.569968          | 1.569968  | 1.569968  | 1.569968  | 1.569968  | .053178                         |  |                              |  |
| 60.00                 | 1.268607          | 1.268607  | 1.268607  | 1.268607  | 1.268607  | .068164                         |  |                              |  |
| 65.00                 | 1.022230          | 1.022230  | 1.022230  | 1.022230  | 1.022230  | .084153                         |  |                              |  |
| 70.00                 | .866242           | .866242   | .866242   | .866242   | .866242   | .100606                         |  |                              |  |
| 75.00                 | .742563           | .742563   | .742563   | .742563   | .742563   | .114965                         |  |                              |  |
| 80.00                 | .628666           | .628666   | .628666   | .628666   | .628666   | .128391                         |  |                              |  |
| 85.00                 | .535810           | .535810   | .535810   | .535810   | .535810   | .135916                         |  |                              |  |
| 90.00                 | .461302           | .461302   | .461302   | .461302   | .461302   | .141954                         |  |                              |  |
| 95.00                 | .400361           | .400361   | .400361   | .400361   | .400361   | .137718                         |  |                              |  |
| 100.00                | .352209           | .352209   | .352209   | .352209   | .352209   | .131317                         |  |                              |  |
| 105.00                | .311627           | .311627   | .311627   | .311627   | .311627   | .111408                         |  |                              |  |
| 110.00                | .280572           | .280572   | .280572   | .280572   | .280572   | .086913                         |  |                              |  |
| 115.00                | .254324           | .254324   | .254324   | .254324   | .254324   | .050430                         |  |                              |  |
| 120.00                | .234666           | .234666   | .234666   | .234666   | .234666   | .007081                         |  |                              |  |
| 125.00                | .219538           | .219538   | .219538   | .219538   | .219538   | -.004018                        |  |                              |  |
| 130.00                | .208937           | .208937   | .208937   | .208937   | .208937   | -.049354                        |  |                              |  |
| 135.00                | .202825           | .202825   | .202825   | .202825   | .202825   | -.158519                        |  |                              |  |
| 140.00                | .200603           | .200603   | .200603   | .200603   | .200603   | -.218510                        |  |                              |  |
| 145.00                | .202907           | .202907   | .202907   | .202907   | .202907   | -.276060                        |  |                              |  |
| 150.00                | .212375           | .212375   | .212375   | .212375   | .212375   | -.324077                        |  |                              |  |
| 155.00                | .229365           | .229365   | .229365   | .229365   | .229365   | -.355063                        |  |                              |  |
| 160.00                | .254039           | .254039   | .254039   | .254039   | .254039   | -.364031                        |  |                              |  |
| 165.00                | .319383           | .319383   | .319383   | .319383   | .319383   | -.293721                        |  |                              |  |
| 170.00                | .451841           | .451841   | .451841   | .451841   | .451841   | -.198050                        |  |                              |  |
| 175.00                | .647278           | .647278   | .647278   | .647278   | .647278   | -.041619                        |  |                              |  |
| 180.00                | .863805           | .863805   | .863805   | .863805   | .863805   | .000000                         |  |                              |  |

TABLE 8. INTENSITY AND POLARIZATION FOR QUARTZ ( $1 \leq \alpha \leq 15$ )

| MATERIALS PRESENT ARE<br>QUARTZ $\mu =$<br>$1 \leq \alpha \leq 15$ |                   | 1.55000   | .000001   | NO OF PARTICLES PER UNIT VOL. = | 4.998518 x 10 <sup>-12</sup> |
|--|-------------------|-----------|-----------|---------------------------------|------------------------------|
| THETA  | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY                       | POLARIZATION                 |
| .00  | 21.901472         | 21.901472 | 21.901472 | 21.901472                       | .000000                      |
| 5.00   | 19.160727         | 19.160727 | 19.194754 | 19.194754                       | -.000731                     |
| 10.00  | 13.963559         | 14.034556 | 13.999057 | 13.999057                       | -.002536                     |
| 15.00  | 10.042656         | 10.073349 | 10.073503 | 10.073503                       | -.003062                     |
| 20.00  | 7.634013          | 7.663418  | 7.648716  | 7.648716                        | -.001922                     |
| 25.00  | 5.937162          | 5.929050  | 5.933106  | 5.933106                        | .000684                      |
| 30.00  | 4.675517          | 4.624942  | 4.650229  | 4.650229                        | .005438                      |
| 35.00  | 3.695007          | 3.620009  | 3.657508  | 3.657508                        | .010253                      |
| 40.00  | 2.944106          | 2.839600  | 2.891853  | 2.891853                        | .018069                      |
| 45.00  | 2.364139          | 2.231102  | 2.297621  | 2.297621                        | .028951                      |
| 50.00  | 1.906574          | 1.757143  | 1.831859  | 1.831859                        | .040787                      |
| 55.00  | 1.553018          | 1.390512  | 1.471765  | 1.471765                        | .055208                      |
| 60.00  | 1.269693          | 1.103007  | 1.186350  | 1.186350                        | .070251                      |
| 65.00  | 1.049309          | .881635   | .965472   | .965472                         | .086835                      |
| 70.00  | .878328           | .716880   | .794604   | .794604                         | .105366                      |
| 75.00  | .733006           | .577524   | .655265   | .655265                         | .118640                      |
| 80.00  | .620190           | .476673   | .548432   | .548432                         | .130844                      |
| 85.00  | .531823           | .394454   | .465638   | .465638                         | .142137                      |
| 90.00  | .455536           | .340530   | .398033   | .398033                         | .144467                      |
| 95.00  | .397577           | .296529   | .347053   | .347053                         | .145579                      |
| 100.00   | .349626           | .266709   | .308167   | .308167                         | .134532                      |
| 105.00   | .309528           | .244269   | .276899   | .276899                         | .117839                      |
| 110.00   | .278200           | .231925   | .255062   | .255062                         | .090712                      |
| 115.00   | .252000           | .226990   | .239495   | .239495                         | .052213                      |
| 120.00   | .233008           | .228179   | .230594   | .230594                         | .010471                      |
| 125.00   | .218568           | .237089   | .227829   | .227829                         | -.040645                     |
| 130.00   | .206445           | .252694   | .229569   | .229569                         | -.100730                     |
| 135.00   | .201177           | .276666   | .238921   | .238921                         | -.157473                     |
| 140.00   | .199929           | .308907   | .254418   | .254418                         | -.214172                     |
| 145.00   | .200596           | .353486   | .277041   | .277041                         | -.275933                     |
| 150.00   | .208951           | .411702   | .310327   | .310327                         | -.326674                     |
| 155.00   | .219067           | .472548   | .345807   | .345807                         | -.366507                     |
| 160.00   | .244729           | .524423   | .384576   | .384576                         | -.363639                     |
| 165.00   | .284290           | .573182   | .428736   | .428736                         | -.336910                     |
| 170.00   | .374416           | .630053   | .502235   | .502235                         | -.254499                     |
| 175.00   | .636621           | .742757   | .689689   | .689689                         | -.076944                     |
| 180.00   | .827129           | .827129   | .827129   | .827129                         | .000000                      |

TABLE 7. INTENSITY AND POLARIZATION FOR QUARTZ ( $1 \leq \alpha \leq 10$ )

| MATERIALS PRESENT ARE |  | 1.55000               |  | .000001   |           | NO OF PARTICLES PER UNIT VOL. = $4.985000 \times 10^{-12}$ |          |
|-----------------------|--|-----------------------|--|-----------|-----------|--|----------|
| QUARTZ $\alpha =$     |  | $1/\alpha \approx 10$ |  |           |           |  |          |
| TMFTA                 |  | GAUSSIAN INTEGRAL     |  | X12 INTEN | INTENSITY | POLARIZATION   |          |
|                       |  | X11 INTEN             |  |           |           |  |          |
| .00                   |  | 16.544262             |  | 16.544262 | 16.544262 |  | .000000  |
| 5.00                  |  | 15.447028             |  | 15.453955 | 15.450497 |  | -.000224 |
| 10.00                 |  | 12.787165             |  | 12.809009 | 12.798087 |  | -.000083 |
| 15.00                 |  | 9.833082              |  | 9.863788  | 9.848436  |  | -.001559 |
| 20.00                 |  | 7.436833              |  | 7.458059  | 7.447446  |  | -.001425 |
| 25.00                 |  | 5.732070              |  | 5.733700  | 5.727845  |  | -.000731 |
| 30.00                 |  | 4.514883              |  | 4.514883  | 4.491981  |  | .005544  |
| 35.00                 |  | 3.598776              |  | 3.599027  | 3.553902  |  | .012627  |
| 40.00                 |  | 2.873076              |  | 2.755770  | 2.814423  |  | .020840  |
| 45.00                 |  | 2.298864              |  | 2.164254  | 2.231559  |  | .030161  |
| 50.00                 |  | 1.854527              |  | 1.704304  | 1.788416  |  | .042749  |
| 55.00                 |  | 1.515218              |  | 1.346263  | 1.430741  |  | .059045  |
| 60.00                 |  | 1.242923              |  | 1.068363  | 1.155643  |  | .075525  |
| 65.00                 |  | 1.024834              |  | .853534   | .939184   |  | .091196  |
| 70.00                 |  | .853570               |  | .685808   | .749649   |  | .108940  |
| 75.00                 |  | .718024               |  | .556563   | .637294   |  | .126677  |
| 80.00                 |  | .608292               |  | .459256   | .533774   |  | .139605  |
| 85.00                 |  | .518973               |  | .384182   | .451577   |  | .149244  |
| 90.00                 |  | .444947               |  | .326965   | .386956   |  | .155034  |
| 95.00                 |  | .389507               |  | .281177   | .337842   |  | .157927  |
| 100.00                |  | .347763               |  | .256249   | .299506   |  | .144428  |
| 105.00                |  | .303891               |  | .235308   | .269640   |  | .127027  |
| 110.00                |  | .272957               |  | .224861   | .248909   |  | .096612  |
| 115.00                |  | .248789               |  | .220476   | .234642   |  | .060289  |
| 120.00                |  | .229112               |  | .221265   | .225188   |  | .017424  |
| 125.00                |  | .214051               |  | .231083   | .222567   |  | -.038263 |
| 130.00                |  | .203441               |  | .247688   | .225564   |  | -.098082 |
| 135.00                |  | .194390               |  | .270387   | .233340   |  | -.158529 |
| 140.00                |  | .183024               |  | .304112   | .248568   |  | -.223456 |
| 145.00                |  | .169210               |  | .347029   | .270119   |  | -.284725 |
| 150.00                |  | .149215               |  | .399757   | .299486   |  | -.334810 |
| 155.00                |  | .206610               |  | .462456   | .334483   |  | -.382301 |
| 160.00                |  | .201579               |  | .504936   | .353258   |  | -.429371 |
| 165.00                |  | .219214               |  | .513198   | .366206   |  | -.401391 |
| 170.00                |  | .351523               |  | .548574   | .450049   |  | -.218922 |
| 175.00                |  | .560940               |  | .644319   | .612630   |  | -.051726 |
| 180.00                |  | .703021               |  | .703021   | .703021   |  | .000000  |

TABLE 6. INTENSITY AND POLARIZATION FOR QUARTZ ( $1 \leq \alpha \leq 5$ )

| MATERIALS PRESENT ARE<br>QUARTZ $\alpha =$<br>$1 \leq \alpha \leq 5$ |                   | 1.55000   | .000001   | NO OF PARTICLES PER UNIT VOL. = $4.960000 \times 10^{-12}$ |              |  |
|--|-------------------|-----------|-----------|--|--------------|--|
| THETA  | GAUSSIAN INTEGRAL | X12 INTEN | X12 INTEN | INTENSITY  | POLARIZATION |  |
| 10.00  | 10.499781         | 10.499781 | 10.499781 | 10.499781  | .000000      |  |
| 5.00   | 10.204439         | 10.204439 | 10.204439 | 10.204439  | .000069      |  |
| 10.00  | 9.375322          | 9.375322  | 9.375322  | 9.377869   | .000272      |  |
| 15.00  | 8.179152          | 8.179152  | 8.179152  | 8.174016   | .000629      |  |
| 20.00  | 6.905184          | 6.905184  | 6.905184  | 6.795529   | .001274      |  |
| 25.00  | 5.453224          | 5.453224  | 5.424990  | 5.439057   | .002605      |  |
| 30.00  | 4.264043          | 4.264043  | 4.217685  | 4.240864   | .005466      |  |
| 35.00  | 3.305274          | 3.305274  | 3.232152  | 3.269719   | .011194      |  |
| 40.00  | 2.579112          | 2.579112  | 2.471640  | 2.525476   | .021238      |  |
| 45.00  | 2.046736          | 2.046736  | 1.992499  | 1.974602   | .036575      |  |
| 50.00  | 1.655667          | 1.655667  | 1.477909  | 1.566889   | .056767      |  |
| 55.00  | 1.359798          | 1.359798  | 1.157083  | 1.259435   | .090536      |  |
| 60.00  | 1.126028          | 1.126028  | .910682   | 1.018366   | .105777      |  |
| 65.00  | .935527           | .935527   | .719343   | .827685  | .130294      |  |
| 70.00  | .770340           | .770340   | .572275   | .675308  | .152571      |  |
| 75.00  | .639402           | .639402   | .459051   | .554226  | .171727      |  |
| 80.00  | .545749           | .545749   | .373069   | .459408  | .187936      |  |
| 85.00  | .484782           | .484782   | .308592   | .396690  | .201966      |  |
| 90.00  | .403081           | .403081   | .261012   | .332046  | .213928      |  |
| 95.00  | .355782           | .355782   | .226592   | .291182  | .221855      |  |
| 100.00   | .317329           | .317329   | .202267   | .259798  | .221446      |  |
| 105.00   | .283234           | .283234   | .185901   | .234568  | .207472      |  |
| 110.00   | .251900           | .251900   | .176477   | .214168  | .176175      |  |
| 115.00   | .224899           | .224899   | .173394   | .193391  | .177924      |  |
| 120.00   | .205054           | .205054   | .178676   | .191870  | .166866      |  |
| 125.00   | .183409           | .183409   | .190656   | .192433  | .167167      |  |
| 130.00   | .167082           | .167082   | .208258   | .197670  | .163363      |  |
| 135.00   | .150256           | .150256   | .228449   | .204357  | .177915      |  |
| 140.00   | .167882           | .167882   | .247571   | .207727  | .191814      |  |
| 145.00   | .150032           | .150032   | .262563   | .206350  | .207927      |  |
| 150.00   | .133607           | .133607   | .272525   | .203066  | .204205      |  |
| 155.00   | .129513           | .129513   | .277492   | .203679  | .364126      |  |
| 160.00   | .146300           | .146300   | .280474   | .213397  | .314392      |  |
| 165.00   | .183851           | .183851   | .292730   | .233091  | .211077      |  |
| 170.00   | .231253           | .231253   | .293969   | .257611  | .102719      |  |
| 175.00   | .270753           | .270753   | .285493   | .278119  | .026499      |  |
| 180.00   | .286102           | .286102   | .286102   | .286102  | .000000      |  |

TABLE 5. INTENSITY AND POLARIZATION FOR ICE ( $1 \leq \alpha \leq 25$ )

| MATERIALS PRESENT ARE   |                   |           |           | NO OF PARTICLES PER UNIT VOL. = |           |              | 4.999680 x 10 <sup>-12</sup> |  |
|-------------------------|-------------------|-----------|-----------|---------------------------------|-----------|--------------|------------------------------|--|
| ICE M =<br>1.5 ≤ α ≤ 25 |                   |           |           | .000001                         |           |              |                              |  |
| THETA                   | GAUSSIAN INTEGRAL |           |           | X12 INTEN                       | INTENSITY | POLARIZATION |                              |  |
|                         | X11 INTEN         |           |           |                                 |           |              |                              |  |
| 0.00                    | 32.163043         | 32.163043 | 32.163043 | 32.163043                       |           | .000000      |                              |  |
| 5.00                    | 23.230191         | 23.301432 | 23.265811 | 23.265811                       |           | -.001531     |                              |  |
| 10.00                   | 13.684718         | 13.762823 | 13.723770 | 13.723770                       |           | -.002846     |                              |  |
| 15.00                   | 9.102543          | 9.148969  | 9.125756  | 9.125756                        |           | -.002544     |                              |  |
| 20.00                   | 6.294278          | 6.295806  | 6.295042  | 6.295042                        |           | -.000121     |                              |  |
| 25.00                   | 4.418862          | 4.370967  | 4.394914  | 4.394914                        |           | .005449      |                              |  |
| 30.00                   | 3.152752          | 3.062885  | 3.107819  | 3.107819                        |           | .019458      |                              |  |
| 35.00                   | 2.289766          | 2.164717  | 2.227241  | 2.227241                        |           | .026073      |                              |  |
| 40.00                   | 1.687993          | 1.539285  | 1.613639  | 1.613639                        |           | .046079      |                              |  |
| 45.00                   | 1.268143          | 1.104414  | 1.186270  | 1.186270                        |           | .069010      |                              |  |
| 50.00                   | .969426           | .797824   | .883625   | .883625                         |           | .097101      |                              |  |
| 55.00                   | .753027           | .579992   | .666510   | .666510                         |           | .129807      |                              |  |
| 60.00                   | .595283           | .424820   | .510052   | .510052                         |           | .167104      |                              |  |
| 65.00                   | .478008           | .313423   | .395716   | .395716                         |           | .207959      |                              |  |
| 70.00                   | .389369           | .233366   | .311366   | .311366                         |           | .250513      |                              |  |
| 75.00                   | .322368           | .175742   | .249065   | .249065                         |           | .294393      |                              |  |
| 80.00                   | .270597           | .134426   | .202512   | .202512                         |           | .336206      |                              |  |
| 85.00                   | .230593           | .105201   | .167897   | .167897                         |           | .373917      |                              |  |
| 90.00                   | .199589           | .084723   | .142156   | .142156                         |           | .404016      |                              |  |
| 95.00                   | .175396           | .070686   | .123041   | .123041                         |           | .425506      |                              |  |
| 100.00                  | .156701           | .061559   | .109130   | .109130                         |           | .435914      |                              |  |
| 105.00                  | .142265           | .056307   | .099286   | .099286                         |           | .432877      |                              |  |
| 110.00                  | .131373           | .054067   | .092720   | .092720                         |           | .416878      |                              |  |
| 115.00                  | .123464           | .054271   | .088668   | .088668                         |           | .389303      |                              |  |
| 120.00                  | .118457           | .056685   | .082571   | .082571                         |           | .352696      |                              |  |
| 125.00                  | .114667           | .061130   | .088899   | .088899                         |           | .312362      |                              |  |
| 130.00                  | .118040           | .067298   | .092669   | .092669                         |           | .273785      |                              |  |
| 135.00                  | .123745           | .074723   | .099224   | .099224                         |           | .247000      |                              |  |
| 140.00                  | .133705           | .082334   | .108019   | .108019                         |           | .237785      |                              |  |
| 145.00                  | .146207           | .088695   | .117451   | .117451                         |           | .244833      |                              |  |
| 150.00                  | .157784           | .093302   | .125543   | .125543                         |           | .256811      |                              |  |
| 155.00                  | .163422           | .099937   | .131680   | .131680                         |           | .241058      |                              |  |
| 160.00                  | .161636           | .115665   | .138651   | .138651                         |           | .165779      |                              |  |
| 165.00                  | .156484           | .145439   | .150962   | .150962                         |           | .036581      |                              |  |
| 170.00                  | .148158           | .166611   | .157385   | .157385                         |           | -.058822     |                              |  |
| 175.00                  | .138669           | .138033   | .138351   | .138351                         |           | .002296      |                              |  |
| 180.00                  | .160082           | .180082   | .180082   | .180082                         |           | .000000      |                              |  |

TABLE 4. INTENSITY AND POLARIZATION FOR ICE ( $1 \leq \alpha \leq 20$ )

| MATERIALS PRESENT ARE<br>ICE N°<br>150520 |                   |           | 1.33000   | •000001   | NO OF PARTICLES PER UNIT VOL. = | 4.999375 x 10 <sup>-12</sup> |
|---|-------------------|-----------|-----------|-----------|---------------------------------|------------------------------|
| THETA                                     | GAUSSIAN INTEGRAL |           | ALL INTER | •12 INTER | INTENSITY                       | POLARIZATION                 |
| •00                                       | 27.946687         | 27.946687 | 27.946687 | 27.946687 | 27.946687                       | •000000                      |
| 5.00                                      | 22.037906         | 22.115913 | 22.037906 | 22.037906 | 22.037906                       | -•001767                     |
| 10.00                                     | 13.557505         | 13.605951 | 13.557505 | 13.605951 | 13.605951                       | -•003616                     |
| 15.00                                     | 8.997224          | 9.037552  | 8.997224  | 9.037552  | 9.037552                        | -•002347                     |
| 20.00                                     | 6.193786          | 6.191757  | 6.193786  | 6.191757  | 6.192761                        | •000165                      |
| 25.00                                     | 4.359270          | 4.360819  | 4.359270  | 4.360819  | 4.363544                        | •006052                      |
| 30.00                                     | 3.116647          | 3.123217  | 3.116647  | 3.123217  | 3.125532                        | •015217                      |
| 35.00                                     | 2.262525          | 2.265910  | 2.262525  | 2.265910  | 2.269217                        | •026787                      |
| 40.00                                     | 1.671467          | 1.674208  | 1.671467  | 1.674208  | 1.676937                        | •047054                      |
| 45.00                                     | 1.255269          | 1.259288  | 1.255269  | 1.259288  | 1.262776                        | •070338                      |
| 50.00                                     | .859927           | .871133   | .859927   | .871133   | .875860                         | •098936                      |
| 55.00                                     | .746314           | .752137   | .746314   | .752137   | .758226                         | •132107                      |
| 60.00                                     | .590064           | .605144   | .590064   | .605144   | .614289                         | •170091                      |
| 65.00                                     | .474194           | .488776   | .474194   | .488776   | .501435                         | •211425                      |
| 70.00                                     | .386526           | .398560   | .386526   | .398560   | .416643                         | •254779                      |
| 75.00                                     | .310327           | .322709   | .310327   | .322709   | .340556                         | •299195                      |
| 80.00                                     | .260672           | .273313   | .260672   | .273313   | .290593                         | •340388                      |
| 85.00                                     | .229404           | .243326   | .229404   | .243326   | .266365                         | •378918                      |
| 90.00                                     | .196526           | .213324   | .196526   | .213324   | .240929                         | •408716                      |
| 95.00                                     | .174514           | .189506   | .174514   | .189506   | .212611                         | •430312                      |
| 100.00                                    | .155782           | .166643   | .155782   | .166643   | .186212                         | •439592                      |
| 105.00                                    | .141367           | .155505   | .141367   | .155505   | .168466                         | •435692                      |
| 110.00                                    | .130303           | .143379   | .130303   | .143379   | .154641                         | •418794                      |
| 115.00                                    | .122395           | .133757   | .122395   | .133757   | .140866                         | •389808                      |
| 120.00                                    | .117347           | .126245   | .117347   | .126245   | .136676                         | •351968                      |
| 125.00                                    | .115150           | .120561   | .115150   | .120561   | .130785                         | •310679                      |
| 130.00                                    | .116266           | .116419   | .116266   | .116419   | .124343                         | •272853                      |
| 135.00                                    | .121261           | .113650   | .121261   | .113650   | .117466                         | •244345                      |
| 140.00                                    | .125072           | .109400   | .125072   | .109400   | .110736                         | •232355                      |
| 145.00                                    | .140676           | .106722   | .140676   | .106722   | .113749                         | •234554                      |
| 150.00                                    | .151099           | .109297   | .151099   | .109297   | .121596                         | •242611                      |
| 155.00                                    | .158664           | .108077   | .158664   | .108077   | .128361                         | •235886                      |
| 160.00                                    | .160023           | .112951   | .160023   | .112951   | .134987                         | •172439                      |
| 165.00                                    | .154515           | .136882   | .154515   | .136882   | .142682                         | •060554                      |
| 170.00                                    | .143177           | .159332   | .143177   | .159332   | .151254                         | -•053403                     |
| 175.00                                    | .130027           | .137327   | .130027   | .137327   | .151662                         | -•014066                     |
| 180.00                                    | .166761           | .166961   | .166761   | .166961   | .166961                         | •000000                      |

TABLE 3. INTENSITY AND POLARIZATION FOR ICE ( $1 \leq \alpha \leq 15$ )

| MATERIALS PRESENT ARE<br>ICE $\alpha =$<br>$1 \leq \alpha \leq 15$ |                   | 1.33600   | .000001   | NO OF PARTICLES PER UNIT VOL. = | 4.988518 x 10 <sup>-12</sup> |
|--|-------------------|-----------|-----------|---------------------------------|------------------------------|
| THETA  | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY                       | POLARIZATION                 |
| 5.00   | 21.601805         | 21.601805 | 21.601805 | 21.601805                       | .000000                      |
| 10.00  | 18.707581         | 18.749673 | 18.749673 | 18.728627                       | -.001124                     |
| 15.00  | 13.123234         | 13.192472 | 13.192472 | 13.157853                       | -.002631                     |
| 20.00  | 8.789527          | 8.829427  | 8.829427  | 8.809477                        | -.002265                     |
| 25.00  | 6.068372          | 6.072126  | 6.072126  | 6.070249                        | -.000009                     |
| 30.00  | 4.284794          | 4.237659  | 4.237659  | 4.261226                        | .005531                      |
| 35.00  | 3.070185          | 2.978480  | 2.978480  | 3.024333                        | .015161                      |
| 40.00  | 2.219196          | 2.094762  | 2.094762  | 2.156979                        | .028844                      |
| 45.00  | 1.641535          | 1.489592  | 1.489592  | 1.565563                        | .048526                      |
| 50.00  | 1.232796          | 1.065324  | 1.065324  | 1.149060                        | .072674                      |
| 55.00  | .940831           | .765830   | .765830   | .853331                         | .102540                      |
| 60.00  | .734279           | .556475   | .556475   | .645377                         | .137752                      |
| 65.00  | .579412           | .405481   | .405481   | .492446                         | .176598                      |
| 70.00  | .466482           | .298727   | .298727   | .382605                         | .219227                      |
| 75.00  | .381105           | .221648   | .221648   | .301377                         | .264548                      |
| 80.00  | .315277           | .166723   | .166723   | .241000                         | .308203                      |
| 85.00  | .265955           | .127223   | .127223   | .196589                         | .352846                      |
| 90.00  | .226445           | .099476   | .099476   | .162961                         | .389567                      |
| 95.00  | .196552           | .080078   | .080078   | .138315                         | .421046                      |
| 100.00   | .172492           | .066786   | .066786   | .119639                         | .441768                      |
| 105.00   | .154025           | .058678   | .058678   | .106352                         | .448262                      |
| 110.00   | .139349           | .053615   | .053615   | .096482                         | .444298                      |
| 115.00   | .128467           | .051972   | .051972   | .090220                         | .423934                      |
| 120.00   | .120243           | .052136   | .052136   | .086189                         | .395102                      |
| 125.00   | .115352           | .054652   | .054652   | .085002                         | .357049                      |
| 130.00   | .112436           | .058080   | .058080   | .085258                         | .318775                      |
| 135.00   | .113542           | .063931   | .063931   | .088737                         | .279540                      |
| 140.00   | .116166           | .068894   | .068894   | .092534                         | .255441                      |
| 145.00   | .122520           | .075977   | .075977   | .099249                         | .234477                      |
| 150.00   | .130702           | .081809   | .081809   | .106255                         | .230072                      |
| 155.00   | .138759           | .087336   | .087336   | .113048                         | .227437                      |
| 160.00   | .149302           | .095259   | .095259   | .122280                         | .220982                      |
| 165.00   | .158930           | .105444   | .105444   | .127187                         | .170956                      |
| 170.00   | .152891           | .129257   | .129257   | .141074                         | .083765                      |
| 175.00   | .136622           | .123955   | .123955   | .127288                         | .026187                      |
| 180.00   | .119664           | .120992   | .120992   | .120328                         | -.005522                     |
|  | .138677           | .138677   | .138677   | .138677                         | .000000                      |



TABLE 2. INTENSITY AND POLARIZATION FOR ICE ( $1 \leq \alpha \leq 10$ )

| MATERIALS PRESENT ARE<br>ICE $H_2O$<br>$15 \leq \alpha \leq 10$ |                   | 1.33000   | .000001   | NO OF PARTICLES PER UNIT VOL. = $4.985000 \times 10^{12}$ |              |
|---|-------------------|-----------|-----------|---|--------------|
| THETA   | GAUSSIAN INTEGRAL | X11 INTEN | X12 INTEN | INTENSITY   | POLARIZATION |
| .00   | 17.462654         | 17.462654 | 17.462654 | 17.462654   | .000000      |
| 5.00  | 15.952939         | 15.952939 | 15.963204 | 15.968072   | -.000948     |
| 10.00   | 12.365928         | 12.365928 | 12.449722 | 12.449722   | -.001377     |
| 15.00   | 8.587935          | 8.587935  | 8.680084  | 8.634009  | -.005336     |
| 20.00   | 5.819487          | 5.819487  | 5.953589  | 5.836538  | -.002921     |
| 25.00   | 4.085274          | 4.085274  | 4.037970  | 4.061622  | .005823      |
| 30.00   | 2.939637          | 2.939637  | 2.934415  | 2.887026  | .018223      |
| 35.00   | 2.117425          | 2.117425  | 1.980615  | 2.049020  | .033384      |
| 40.00   | 1.549247          | 1.549247  | 1.388432  | 1.468839  | .054742      |
| 45.00   | 1.177721          | 1.177721  | .990241   | 1.080441  | .083518      |
| 50.00   | .901700           | .901700   | .713259   | .807480   | .116685      |
| 55.00   | .700132           | .700132   | .513950   | .607041   | .153352      |
| 60.00   | .551582           | .551582   | .372508   | .463045   | .195525      |
| 65.00   | .448321           | .448321   | .273284   | .368003   | .242566      |
| 70.00   | .368061           | .368061   | .202322   | .285192   | .290575      |
| 75.00   | .304426           | .304426   | .150888   | .227457   | .337214      |
| 80.00   | .255947           | .255947   | .114310   | .185178   | .382538      |
| 85.00   | .219879           | .219879   | .088869   | .154374   | .424328      |
| 90.00   | .190723           | .190723   | .071087   | .130905   | .456957      |
| 95.00   | .164379           | .164379   | .058994   | .112687   | .476478      |
| 100.00  | .148370           | .148370   | .051599   | .099985   | .483931      |
| 105.00  | .135133           | .135133   | .047273   | .091203   | .481673      |
| 110.00  | .123442           | .123442   | .044948   | .084195   | .464149      |
| 115.00  | .114579           | .114579   | .045195   | .079887   | .434262      |
| 120.00  | .108892           | .108892   | .047529   | .078711   | .396155      |
| 125.00  | .104228           | .104228   | .049903   | .078065   | .367557      |
| 130.00  | .103472           | .103472   | .052742   | .078107   | .324745      |
| 135.00  | .105275           | .105275   | .058164   | .081719   | .288248      |
| 140.00  | .108453           | .108453   | .064560   | .086507   | .253692      |
| 145.00  | .108624           | .108624   | .069286   | .088955   | .221116      |
| 150.00  | .113779           | .113779   | .075548   | .094413   | .199819      |
| 155.00  | .126931           | .126931   | .087151   | .106541   | .181995      |
| 160.00  | .128703           | .128703   | .098953   | .113828   | .130677      |
| 165.00  | .117341           | .117341   | .103279   | .106810   | .033059      |
| 170.00  | .092604           | .092604   | .101973   | .097289   | -.048150     |
| 175.00  | .095351           | .095351   | .101514   | .098432   | -.031307     |
| 180.00  | .102084           | .102084   | .102084   | .102084   | .000000      |

TABLE 1. INTENSITY AND POLARIZATION FOR ICE ( $1 \leq \alpha \leq 5$ )

| MATERIALS PRESENT ARE            |                   | 1.33000   |           | .000001   |              | NO OF PARTICLES PER UNIT VOL. = $4.960000 \times 10^{-12}$ |  |
|----------------------------------|-------------------|-----------|-----------|-----------|--------------|--|--|
| ICE $\mu = 1 \leq \alpha \leq 5$ |                   |           |           |           |              |  |  |
| THETA                            | GAUSSIAN INTEGRAL |           |           |           |              |  |  |
|                                  |                   | XI1 INTEN | XI2 INTEN | INTENSITY | POLARIZATION |  |  |
| 5.00                             | 6.077601          | 6.077601  | 6.077601  | 6.077601  | .000000      |  |  |
| 10.00                            | 5.912685          | 5.912685  | 5.904200  | 5.904200  | .001437      |  |  |
| 15.00                            | 5.462255          | 5.384284  | 5.415270  | 5.415270  | .005722      |  |  |
| 20.00                            | 4.755533          | 4.635476  | 4.695505  | 4.695505  | .012784      |  |  |
| 25.00                            | 3.946134          | 3.772206  | 3.859200  | 3.859200  | .022542      |  |  |
| 30.00                            | 3.126339          | 2.915015  | 3.020677  | 3.020677  | .034979      |  |  |
| 35.00                            | 2.393359          | 2.155039  | 2.269199  | 2.269199  | .050309      |  |  |
| 40.00                            | 1.770168          | 1.540962  | 1.655565  | 1.655565  | .069223      |  |  |
| 45.00                            | 1.303140          | 1.081083  | 1.192111  | 1.192111  | .093136      |  |  |
| 50.00                            | .969783           | .755742   | .862763   | .862763   | .124044      |  |  |
| 55.00                            | .741413           | .532905   | .637159   | .637159   | .163624      |  |  |
| 60.00                            | .585673           | .380816   | .483245   | .483245   | .211960      |  |  |
| 65.00                            | .475291           | .274861   | .375076   | .375076   | .267187      |  |  |
| 70.00                            | .391813           | .198988   | .295401   | .295401   | .326378      |  |  |
| 75.00                            | .325150           | .143860   | .234505   | .234505   | .386533      |  |  |
| 80.00                            | .270874           | .104082   | .187478   | .187478   | .444829      |  |  |
| 85.00                            | .227186           | .076042   | .151614   | .151614   | .498453      |  |  |
| 90.00                            | .192813           | .056810   | .124812   | .124812   | .544833      |  |  |
| 95.00                            | .166160           | .043894   | .105722   | .105722   | .582145      |  |  |
| 100.00                           | .145406           | .035285   | .090346   | .090346   | .609442      |  |  |
| 105.00                           | .128956           | .029670   | .079313   | .079313   | .625910      |  |  |
| 110.00                           | .115750           | .026291   | .071021   | .071021   | .629811      |  |  |
| 115.00                           | .105228           | .024822   | .065025   | .065025   | .618274      |  |  |
| 120.00                           | .097037           | .025140   | .061088   | .061088   | .588471      |  |  |
| 125.00                           | .090713           | .027139   | .058926   | .058926   | .539442      |  |  |
| 130.00                           | .085562           | .030626   | .058094   | .058094   | .472823      |  |  |
| 135.00                           | .080817           | .035303   | .058069   | .058069   | .391953      |  |  |
| 140.00                           | .075970           | .040818   | .058394   | .058394   | .300994      |  |  |
| 145.00                           | .071076           | .046829   | .058953   | .058953   | .205647      |  |  |
| 150.00                           | .066813           | .053062   | .059937   | .059937   | .114717      |  |  |
| 155.00                           | .064222           | .059306   | .061764   | .061764   | .039791      |  |  |
| 160.00                           | .064203           | .065380   | .064792   | .064792   | -.009083     |  |  |
| 165.00                           | .067007           | .071067   | .069037   | .069037   | -.029407     |  |  |
| 170.00                           | .071945           | .076074   | .074010   | .074010   | -.027898     |  |  |
| 175.00                           | .077508           | .080043   | .078775   | .078775   | -.016086     |  |  |
| 180.00                           | .081857           | .082608   | .082233   | .082233   | -.004568     |  |  |
|                                  | .083498           | .083498   | .083498   | .083498   | .000000      |  |  |

## TABLES AND GRAPHS FOR POLARIZATION AND INTENSITIES

In Tables 1 through 40 the normalized intensity, the total normalized intensity, and the degree of polarization are given for each 5 degrees of the angle for the following materials:

|                      |                    |
|----------------------|--------------------|
| Water (ice)          | $m = 1.33 - 0.00i$ |
| Water (dirty ice I)  | $m = 1.33 - 0.05i$ |
| Water (dirty ice II) | $m = 1.33 - 0.10i$ |
| Titanite             | $m = 2.00 - 0.00i$ |
| Quartz               | $m = 1.55 - 0.00i$ |
| Iron                 | $m = 1.27 - 1.37i$ |
| Zinc                 | $m = 1.41 - 4.10i$ |
| Graphite             | $m = 1.59 - 0.66i$ |

The particle size ranges are 1(5)25.

Only the total intensity and degree of polarization are shown in Figures 2 through 81. In the tables:

$$\text{XI1 INTEN} = I_1(\theta)$$

$$\text{XI2 INTEN} = I_2(\theta)$$

$$\text{INTENSITY} = \frac{1}{2}(\text{XI1} + \text{XI2})$$

$$\text{POLARIZATION} = \frac{\text{XI1} - \text{XI2}}{\text{XI1} + \text{XI2}}$$

$$\text{THETA} = \text{angle between the incident and scattered direction.}$$

The heading Gaussian Integral should be ignored since it is an artifact of the programming and contributes no information to the tables.

For the Gauss-Legendre quadrature, the  $y_s$  are the  $s^{\text{th}}$  zeros of the Legendre polynomials  $P_n(x)$ , and the  $W_s$  are weighting functions. Both  $W_s$  and  $y_s$  are tabulated [6]. In the trapezoidal quadrature,  $h$  is the increment of integration. It has been found that the size of the integration increment is extremely important [7]. To study this effect, a 5-, 16-, and 96-point Gauss-Legendre scheme and the trapezoidal quadrature, for comparison, were used separately to calculate  $i_1$ ,  $i_2$ , and the polarization. A discussion of the results is given in the appendix.

## Distribution

The only distribution function included in this report is the inverse power law:

$$n(\alpha) = b\alpha^{-k},$$

with  $k = 4$ . It is limited to the inverse power in order that  $n(\alpha)$  decreases as  $\alpha$  increases. This distribution function is useful when using a range of sizes that has a certain decay rate. The term  $b$  is related to the total number of particles per unit volume  $N'$  by

$$b = \frac{(k+1) N'}{\alpha_{\min}^{-k+1} - \alpha_{\max}^{-k+1}},$$

which is found simply by integration. The integral diverges at  $\alpha = 0$ , and, hence, a finite lower limit must always be included. The slope of the  $\ln n(\alpha)$ -versus- $\ln \alpha$  curve is easily found and is

$$\frac{d \ln n(\alpha)}{d \ln (\alpha)} = -k.$$

Figure 82 shows the range and values of the distribution for several values of  $k$ . Also, it should be noted that regardless of the power of  $k$ , the smaller size particles dominate the inverse power distribution.

The distribution function in terms of the radius  $r$  is given by

$$n(r) = b \left( \frac{\lambda}{2\pi} \right)^k r^{-k}.$$

To determine polarization effects, the degree of polarization defined by

$$P(\theta) = \frac{i_1(m, \alpha, \theta) - i_2(m, \alpha, \theta)}{i_1(m, \alpha, \theta) + i_2(m, \alpha, \theta)}$$

is used. For the general case of the nonhomogeneous polydispersed cloud, the expression for  $P(\theta)$  becomes

$$P(\theta) = \frac{\sum_{q=1}^Q \int_{\alpha_{\min}}^{\alpha_{\max}} i_1(m_q, \alpha, \theta) n(\alpha) d\alpha - \sum_{q=1}^Q \int_{\alpha_{\min}}^{\alpha_{\max}} i_2(m_q, \alpha, \theta) n(\alpha) d\alpha}{\sum_{q=1}^Q \int_{\alpha_{\min}}^{\alpha_{\max}} [i_1(m_q, \alpha, \theta) n(\alpha) d\alpha + i_2(m_q, \alpha, \theta) n(\alpha) d\alpha]}$$

Two methods have been used to program these equations for the computer, a Gauss-Legendre quadrature and the trapezoidal quadrature. The integrals were normalized by the total number of particles in a unit volume

$$\int_{\alpha_{\min}}^{\alpha_{\max}} n(\alpha) d\alpha$$

and it is this normalized scattering function which is given in Tables 1 through 40 and Figures 2 through 81. With the Gauss-Legendre scheme [4]

$$\int_a^b i(m, \alpha, \theta) n(\alpha) d\alpha = \frac{b-a}{2} \sum_{s=1}^S W_s i(m, \theta, y_s) n(y_s),$$

where

$$y_s = \left(\frac{b-a}{2}\right) \alpha_s + \left(\frac{b+a}{2}\right)$$

The trapezoidal quadrature is

$$\int_a^b f(x) dx = \left[ \frac{f(a)}{2} + f(a+1) + \dots + f(b-1) + \frac{f(b)}{2} \right] h.$$

and

$$I_{\text{total}}(\theta) = \frac{1}{2} [I_1(\theta) + I_2(\theta)] .$$

If the cloud is monodispersed and homogeneous, then

$$I_{\text{total}}(\theta) = N \left[ \frac{i_1(m, \alpha, \theta) + i_2(m, \alpha, \theta)}{2} \right] ,$$

where  $N$  is the total number of particles in the scattering volume. For a homogeneous polydispersed collection of particles

$$I_{\text{total}}(\theta) = \sum_{\ell=1}^L \frac{i_1(m, \alpha_{\ell}, \theta) + i_2(m, \alpha_{\ell}, \theta)}{2} n(\alpha_{\ell}) \Delta \alpha_{\ell} ,$$

where  $n(\alpha)$  is the distribution function for the particle sizes. The term  $n(\alpha)$  plays the part of a weighting function. The total number of particles per unit volume is given by  $\sum n(\alpha) \Delta \alpha$ ; hence  $N = \left[ \sum n(\alpha) \Delta \alpha \right] \times \text{volume}$ .

If the distribution is smooth and continuous, then the summation can be replaced by an integral

$$I_{\text{total}}(\theta) = \frac{1}{2} \int_{\alpha_{\min}}^{\alpha_{\max}} [i_1(m, \alpha, \theta) + i_2(m, \alpha, \theta)] n(\alpha) d\alpha$$

and

$$I_c(\theta) = \int_{\alpha_{\min}}^{\alpha_{\max}} i_c(m, \alpha, \theta) n(\alpha) d\alpha , \quad \text{where } c = 1, 2 .$$

In addition, if the cloud is nonhomogeneous but consists of several different materials, then

$$I_{\text{total}}(\theta) = \sum_{q=1}^Q \frac{1}{2} \int_{\alpha_{\min}}^{\alpha_{\max}} [i_1(m_q, \alpha, \theta) + i_2(m_q, \alpha, \theta)] n(\alpha) d\alpha .$$

$\lambda$  = wavelength of the incident light,

$\theta$  = scattering angle,

$\beta = m\alpha$ ,

$J_{n+1/2}$  = half-integral order Bessel function,

$H_{n+1/2}^{(2)}$  = half-integral order Hankel function of second kind.

The terms  $\frac{\lambda^2 i_1}{8\pi^2}$  and  $\frac{\lambda^2 i_2}{8\pi^2}$  give the radiant intensities of the scattered components polarized perpendicular and parallel, respectively, to the plane of scattering when the sphere is illuminated by unpolarized monochromatic incident light of unit intensity. The plane of scattering is defined as the plane containing the sphere, the incident light direction, and the scattered light direction. (See Fig. 1.)

The differential scattering cross section is the ratio of the energy scattered in a given direction per unit solid angle per unit time to the energy incident per unit area per unit time. It is given by Penndorf [5].

$$\frac{d\sigma}{d\Omega} = \frac{\lambda^2}{8\pi^2} (i_1 + i_2) \quad . \quad (\text{area/steradian})$$

Some authors call this the angular scattering cross section.

The Mie theory can easily be extended to a cloud of particles if the light reaching the point of observation has encountered only one scatterer and if the particles are randomly oriented in space so that there are no phase effects. With these assumptions, the total scattered intensity in a particular direction is the sum of the intensities scattered from each particle,

$$I_c(\theta) = \sum_{q=1}^Q \sum_{l=1}^L i_c(m_q, \alpha_l, \theta) \quad \text{where } c = 1, 2 \quad ,$$

and

$$i_2(m, \alpha, \theta) = \left| \sum_{n=1}^{\infty} \left\{ A_n \left[ x \frac{dP_n(x)}{dx} - (1-x)^2 \frac{d^2 P_n(x)}{dx^2} \right] + B_n \frac{dP_n(x)}{dx} \right\} \right|^2,$$

where

$i_1$  and  $i_2$  are scattered intensity functions,

$P_n(x)$  is a Legendre polynomial of order  $n$ ,

$x = -\cos \theta$ .

$A_n$  and  $B_n$  are amplitude functions given by

$$A_n = \left( i^{2n+1} \right) \frac{2n+1}{n(n+1)} \frac{\psi_n(\alpha) \frac{d\psi_n(\beta)}{d\beta} - m\psi_n(\beta) \frac{d\psi_n(\alpha)}{d\alpha}}{\zeta_n(\alpha) \frac{d\psi_n(\beta)}{d\beta} - m\psi_n(\beta) \frac{d\zeta_n(\alpha)}{d\alpha}}$$

and

$$B_n = \left( -i^{2n+1} \right) \frac{2n+1}{n(n+1)} \frac{\psi_n(\beta) \frac{d\psi_n(\alpha)}{d\alpha} - m\psi_n(\alpha) \frac{d\psi_n(\beta)}{d\beta}}{\psi_n(\beta) \frac{d\zeta_n(\alpha)}{d\alpha} - m\zeta_n(\alpha) \frac{d\psi_n(\beta)}{d\beta}},$$

where

$$\psi_n = \text{Ricatti Bessel function} \left( \frac{\pi\alpha}{2} \right)^{1/2} J_{n+1/2}(\alpha),$$

$$\zeta_n = \text{Ricatti Bessel function} \left( \frac{\pi\alpha}{2} \right)^{1/2} H_{n+1/2}^{(2)}(\alpha),$$

$$\alpha = \frac{2\pi a}{\lambda} = \text{particle size parameter},$$

$$m = \text{complex refractive index},$$



# A CATALOGUE OF NORMALIZED INTENSITY FUNCTIONS AND POLARIZATION FROM A CLOUD OF PARTICLES WITH A SIZE DISTRIBUTION OF $\alpha^{-1}$

## INTRODUCTION

The so-called theory of light scattering from single spheres can be extended to a collection of spheres of different sizes. The sizes will vary according to some distribution function. Using the distribution function, one can calculate the average scattering cross section for any angle. If such cross sections are calculated beforehand, the computer time required for light scattering calculations can be shortened. It is with this thought in mind that this report is written. The materials have been limited primarily to those that have been used in modeling the astronomical phenomenon, zodiacal light, where single particle scattering can be considered sufficient.

In the course of studying the effects of distributions, it became clear that certain parameters strongly influence the results of the scattering by a distribution of particles. They are the obvious physical parameters, particle size range, refractive index, and the not-so-obvious numerical parameter, the integration increment. The effects of all three parameters are investigated.

Only particles of spherical shape are considered since this is the only shape for which the problem of scattering of electromagnetic radiation has been solved exactly in closed form and which is easily adapted to the computer.

## THEORY

The development of the Mie theory is repeated in the literature [1-3]. The basic expressions [4] for the radiation scattered from a sphere of radius  $a$  and refractive index  $m$  are:

$$i_1(m, \alpha, \theta) = \left| \sum_{n=1}^{\infty} \left\{ A_n \frac{dP_n(x)}{dx} + B_n \left[ x \frac{dP_n(x)}{dx} - (1-x)^2 \frac{d^2 P_n(x)}{dx^2} \right] \right\} \right|^2$$

## LIST OF TABLES (Concluded)

| Table | Title  | Page |
|-------|--|------|
| A-1.  | Comparison of 96-Point Gauss-Legendre and Trapezoidal Quadrature for Mixture of Quartz and Ice ( $1 \leq \alpha \leq 20$ ) . . . . . | 133  |

## LIST OF TABLES (Continued)

| Table | Title   | Page |
|-------|---|------|
| 21.   | Intensity and Polarization for Ice II ( $1 \leq \alpha \leq 5$ ) . . . .    | 28   |
| 22.   | Intensity and Polarization for Ice II ( $1 \leq \alpha \leq 10$ ) . . . .   | 29   |
| 23.   | Intensity and Polarization for Ice II ( $1 \leq \alpha \leq 15$ ) . . . .   | 30   |
| 24.   | Intensity and Polarization for Ice II ( $1 \leq \alpha \leq 20$ ) . . . .   | 31   |
| 25.   | Intensity and Polarization for Ice II ( $1 \leq \alpha \leq 25$ ) . . . .   | 32   |
| 26.   | Intensity and Polarization for Graphite ( $1 \leq \alpha \leq 5$ ). . . .   | 33   |
| 27.   | Intensity and Polarization for Graphite ( $1 \leq \alpha \leq 10$ ) . . . . | 34   |
| 28.   | Intensity and Polarization for Graphite ( $1 \leq \alpha \leq 15$ ) . . . . | 35   |
| 29.   | Intensity and Polarization for Graphite ( $1 \leq \alpha \leq 20$ ) . . . . | 36   |
| 30.   | Intensity and Polarization for Graphite ( $1 \leq \alpha \leq 25$ ) . . . . | 37   |
| 31.   | Intensity and Polarization for Iron ( $1 \leq \alpha \leq 5$ ). . . . .     | 38   |
| 32.   | Intensity and Polarization for Iron ( $1 \leq \alpha \leq 10$ ) . . . . .   | 39   |
| 33.   | Intensity and Polarization for Iron ( $1 \leq \alpha \leq 15$ ) . . . . .   | 40   |
| 34.   | Intensity and Polarization for Iron ( $1 \leq \alpha \leq 20$ ) . . . . .   | 41   |
| 35.   | Intensity and Polarization for Iron ( $1 \leq \alpha \leq 25$ ) . . . . .   | 42   |
| 36.   | Intensity and Polarization for Zinc ( $1 \leq \alpha \leq 5$ ). . . . .     | 43   |
| 37.   | Intensity and Polarization for Zinc ( $1 \leq \alpha \leq 10$ ) . . . . .   | 44   |
| 38.   | Intensity and Polarization for Zinc ( $1 \leq \alpha \leq 15$ ) . . . . .   | 45   |
| 39.   | Intensity and Polarization for Zinc ( $1 \leq \alpha \leq 20$ ) . . . . .   | 46   |
| 40.   | Intensity and Polarization for Zinc ( $1 \leq \alpha \leq 25$ ) . . . . .   | 47   |

# LIST OF TABLES

| Table | Title   | Page |
|-------|---|------|
| 1.    | Intensity and Polarization for Ice ( $1 \leq \alpha \leq 5$ ) . . . . .       | 8    |
| 2.    | Intensity and Polarization for Ice ( $1 \leq \alpha \leq 10$ ) . . . . .      | 9    |
| 3.    | Intensity and Polarization for Ice ( $1 \leq \alpha \leq 15$ ) . . . . .      | 10   |
| 4.    | Intensity and Polarization for Ice ( $1 \leq \alpha \leq 20$ ) . . . . .      | 11   |
| 5.    | Intensity and Polarization for Ice ( $1 \leq \alpha \leq 25$ ) . . . . .      | 12   |
| 6.    | Intensity and Polarization for Quartz ( $1 \leq \alpha \leq 5$ ) . . . . .    | 13   |
| 7.    | Intensity and Polarization for Quartz ( $1 \leq \alpha \leq 10$ ) . . . . .   | 14   |
| 8.    | Intensity and Polarization for Quartz ( $1 \leq \alpha \leq 15$ ) . . . . .   | 15   |
| 9.    | Intensity and Polarization for Quartz ( $1 \leq \alpha \leq 20$ ) . . . . .   | 16   |
| 10.   | Intensity and Polarization for Quartz ( $1 \leq \alpha \leq 25$ ) . . . . .   | 17   |
| 11.   | Intensity and Polarization for Titanite ( $1 \leq \alpha \leq 5$ ) . . . . .  | 18   |
| 12.   | Intensity and Polarization for Titanite ( $1 \leq \alpha \leq 10$ ) . . . . . | 19   |
| 13.   | Intensity and Polarization for Titanite ( $1 \leq \alpha \leq 15$ ) . . . . . | 20   |
| 14.   | Intensity and Polarization for Titanite ( $1 \leq \alpha \leq 20$ ) . . . . . | 21   |
| 15.   | Intensity and Polarization for Titanite ( $1 \leq \alpha \leq 25$ ) . . . . . | 22   |
| 16.   | Intensity and Polarization for Ice I ( $1 \leq \alpha \leq 5$ ) . . . . .     | 23   |
| 17.   | Intensity and Polarization for Ice I ( $1 \leq \alpha \leq 10$ ) . . . . .    | 24   |
| 18.   | Intensity and Polarization for Ice I ( $1 \leq \alpha \leq 15$ ) . . . . .    | 25   |
| 19.   | Intensity and Polarization for Ice I ( $1 \leq \alpha \leq 20$ ) . . . . .    | 26   |
| 20.   | Intensity and Polarization for Ice I ( $1 \leq \alpha \leq 25$ ) . . . . .    | 27   |

## LIST OF ILLUSTRATIONS (Concluded)

| Figure | Title   | Page |
|--------|---|------|
| A-10.  | Degree of polarization for 50 percent quartz, 50 percent ice mixture using 96-point Gaussian quadrature ( $\alpha$ min = 1.0, $\alpha$ max = 20.0). . . . .           | 143  |
| A-11.  | Total scattering intensity function from the trapezoidal rule for a mixture of half quartz and half ice ( $\Delta \alpha = 0.1$ ) . .                                 | 144  |
| A-12.  | Degree of polarization from the trapezoidal rule using a mixture of half quartz and half ice ( $\Delta \alpha = 0.1$ ) . . . . .                                      | 145  |
| A-13.  | A comparison of the degree of polarization from three Gauss-Legendre integration schemes. . . . .   | 146  |
| A-14.  | Total intensity curves for quartz as obtained from the trapezoidal rule and integration increments of $\Delta \alpha = 0.1, 0.3$ , and $0.5$ . . . . .                | 147  |
| A-15.  | Comparison of the degree of polarization for quartz obtained from the trapezoidal rule and integration increments of $\Delta \alpha = 0.1, 0.3$ , and $0.5$ . . . . . | 148  |

## LIST OF ILLUSTRATIONS (Continued)

| Figure | Title   | Page |
|--------|---|------|
| 79.    | Polarization versus scattering angle for zinc<br>with $1 \leq \alpha \leq 15$ .....   | 126  |
| 80.    | Polarization versus scattering angle for zinc<br>with $1 \leq \alpha \leq 20$ .....   | 127  |
| 81.    | Polarization versus scattering angle for zinc<br>with $1 \leq \alpha \leq 25$ .....   | 128  |
| 82.    | Size distribution for inverse power law .....   | 129  |
| A-1.   | Total scattering intensity function for water using the<br>5-point Gauss-Legendre integration .....   | 134  |
| A-2.   | Total scattering intensity function for water using the<br>96-point Gauss-Legendre integration .....  | 135  |
| A-3.   | Degree of polarization for water from the<br>5-point Gauss-Legendre integration .....   | 136  |
| A-4.   | Degree of polarization for water using the<br>96-point Gauss-Legendre integration .....   | 137  |
| A-5.   | Total scattering intensity function for zinc using the<br>5-point Gauss-Legendre integration .....  | 138  |
| A-6.   | Total scattering intensity function for zinc using the<br>96-point Gauss-Legendre integration .....   | 139  |
| A-7.   | Degree of polarization for zinc from the<br>5-point Gauss-Legendre integration .....  | 140  |
| A-8.   | Degree of polarization for zinc using the<br>96-point Gauss-Legendre integration .....  | 141  |
| A-9.   | Total scattering intensity function for 50 percent quartz,<br>50 percent ice using the 96-point Gaussian quadrature<br>( $\alpha$ min = 1.0, $\alpha$ max = 20.0) ..... | 142  |

## LIST OF ILLUSTRATIONS (Continued)

| Figure | Title   | Page |
|--------|---|------|
| 66.    | Polarization versus scattering angle for water (ice II)<br>with $1 \leq \alpha \leq 25$ . . . . . | 113  |
| 67.    | Polarization versus scattering angle for graphite<br>with $1 \leq \alpha \leq 5$ . . . . .        | 114  |
| 68.    | Polarization versus scattering angle for graphite<br>with $1 \leq \alpha \leq 10$ . . . . .       | 115  |
| 69.    | Polarization versus scattering angle for graphite<br>with $1 \leq \alpha \leq 15$ . . . . .       | 116  |
| 70.    | Polarization versus scattering angle for graphite<br>with $1 \leq \alpha \leq 20$ . . . . .       | 117  |
| 71.    | Polarization versus scattering angle for graphite<br>with $1 \leq \alpha \leq 25$ . . . . .       | 118  |
| 72.    | Polarization versus scattering angle for iron<br>with $1 \leq \alpha \leq 5$ . . . . .            | 119  |
| 73.    | Polarization versus scattering angle for iron<br>with $1 \leq \alpha \leq 10$ . . . . .           | 120  |
| 74.    | Polarization versus scattering angle for iron<br>with $1 \leq \alpha \leq 15$ . . . . .           | 121  |
| 75.    | Polarization versus scattering angle for iron<br>with $1 \leq \alpha \leq 20$ . . . . .           | 122  |
| 76.    | Polarization versus scattering angle for iron<br>with $1 \leq \alpha \leq 25$ . . . . .           | 123  |
| 77.    | Polarization versus scattering angle for zinc<br>with $1 \leq \alpha \leq 5$ . . . . .            | 124  |
| 78.    | Polarization versus scattering angle for zinc<br>with $1 \leq \alpha \leq 10$ . . . . .           | 125  |

## LIST OF ILLUSTRATIONS (Continued)

| Figure | Title   | Page |
|--------|---|------|
| 53.    | Polarization versus scattering angle for titanite<br>with $1 \leq \alpha \leq 10$ . . . . .       | 100  |
| 54.    | Polarization versus scattering angle for titanite<br>with $1 \leq \alpha \leq 15$ . . . . .       | 101  |
| 55.    | Polarization versus scattering angle for titanite<br>with $1 \leq \alpha \leq 20$ . . . . .       | 102  |
| 56.    | Polarization versus scattering angle for titanite<br>with $1 \leq \alpha \leq 25$ . . . . .       | 103  |
| 57.    | Polarization versus scattering angle for water (ice I)<br>with $1 \leq \alpha \leq 5$ . . . . .   | 104  |
| 58.    | Polarization versus scattering angle for water (ice I)<br>with $1 \leq \alpha \leq 10$ . . . . .  | 105  |
| 59.    | Polarization versus scattering angle for water (ice I)<br>with $1 \leq \alpha \leq 15$ . . . . .  | 106  |
| 60.    | Polarization versus scattering angle for water (ice I)<br>with $1 \leq \alpha \leq 20$ . . . . .  | 107  |
| 61.    | Polarization versus scattering angle for water (ice I)<br>with $1 \leq \alpha \leq 25$ . . . . .  | 108  |
| 62.    | Polarization versus scattering angle for water (ice II)<br>with $1 \leq \alpha \leq 5$ . . . . .  | 109  |
| 63.    | Polarization versus scattering angle for water (ice II)<br>with $1 \leq \alpha \leq 10$ . . . . . | 110  |
| 64.    | Polarization versus scattering angle for water (ice II)<br>with $1 \leq \alpha \leq 15$ . . . . . | 111  |
| 65.    | Polarization versus scattering angle for water (ice II)<br>with $1 \leq \alpha \leq 20$ . . . . . | 112  |



## LIST OF ILLUSTRATIONS (Continued)

| Figure | Title  | Page |
|--------|--|------|
| 40.    | Intensity versus scattering angle for zinc<br>with $1 \leq \alpha \leq 20$ . . . . .           | 87   |
| 41.    | Intensity versus scattering angle for zinc<br>with $1 \leq \alpha \leq 25$ . . . . .           | 88   |
| 42.    | Polarization versus scattering angle for quartz<br>with $1 \leq \alpha \leq 5$ . . . . .       | 89   |
| 43.    | Polarization versus scattering angle for quartz<br>with $1 \leq \alpha \leq 10$ . . . . .      | 90   |
| 44.    | Polarization versus scattering angle for quartz<br>with $1 \leq \alpha \leq 15$ . . . . .      | 91   |
| 45.    | Polarization versus scattering angle for quartz<br>with $1 \leq \alpha \leq 20$ . . . . .      | 92   |
| 46.    | Polarization versus scattering angle for quartz<br>with $1 \leq \alpha \leq 25$ . . . . .      | 93   |
| 47.    | Polarization versus scattering angle for water (ice)<br>with $1 \leq \alpha \leq 5$ . . . . .  | 94   |
| 48.    | Polarization versus scattering angle for water (ice)<br>with $1 \leq \alpha \leq 10$ . . . . . | 95   |
| 49.    | Polarization versus scattering angle for water (ice)<br>with $1 \leq \alpha \leq 15$ . . . . . | 96   |
| 50.    | Polarization versus scattering angle for water (ice)<br>with $1 \leq \alpha \leq 20$ . . . . . | 97   |
| 51.    | Polarization versus scattering angle for water (ice)<br>with $1 \leq \alpha \leq 25$ . . . . . | 98   |
| 52.    | Polarization versus scattering angle for titanite<br>with $1 \leq \alpha \leq 5$ . . . . .     | 99   |

## LIST OF ILLUSTRATIONS (Continued)

| Figure | Title  | Page |
|--------|--|------|
| 27.    | Intensity versus scattering angle for graphite<br>with $1 \leq \alpha \leq 5$ .....  | 74   |
| 28.    | Intensity versus scattering angle for graphite<br>with $1 \leq \alpha \leq 10$ ..... | 75   |
| 29.    | Intensity versus scattering angle for graphite<br>with $1 \leq \alpha \leq 15$ ..... | 76   |
| 30.    | Intensity versus scattering angle for graphite<br>with $1 \leq \alpha \leq 20$ ..... | 77   |
| 31.    | Intensity versus scattering angle for graphite<br>with $1 \leq \alpha \leq 25$ ..... | 78   |
| 32.    | Intensity versus scattering angle for iron<br>with $1 \leq \alpha \leq 5$ .....      | 79   |
| 33.    | Intensity versus scattering angle for iron<br>with $1 \leq \alpha \leq 10$ .....     | 80   |
| 34.    | Intensity versus scattering angle for iron<br>with $1 \leq \alpha \leq 15$ .....     | 81   |
| 35.    | Intensity versus scattering angle for iron<br>with $1 \leq \alpha \leq 20$ .....     | 82   |
| 36.    | Intensity versus scattering angle for iron<br>with $1 \leq \alpha \leq 25$ .....     | 83   |
| 37.    | Intensity versus scattering angle for zinc<br>with $1 \leq \alpha \leq 5$ .....      | 84   |
| 38.    | Intensity versus scattering angle for zinc<br>with $1 \leq \alpha \leq 10$ .....     | 85   |
| 39.    | Intensity versus scattering angle for zinc<br>with $1 \leq \alpha \leq 15$ .....     | 86   |

## LIST OF ILLUSTRATIONS (Continued)

| Figure | Title  | Page |
|--------|--|------|
| 14.    | Intensity versus scattering angle for titanite<br>with $1 \leq \alpha \leq 15$ . . . . .       | 61   |
| 15.    | Intensity versus scattering angle for titanite<br>with $1 \leq \alpha \leq 20$ . . . . .       | 62   |
| 16.    | Intensity versus scattering angle for titanite<br>with $1 \leq \alpha \leq 25$ . . . . .       | 63   |
| 17.    | Intensity versus scattering angle for water (ice I)<br>with $1 \leq \alpha \leq 5$ . . . . .   | 64   |
| 18.    | Intensity versus scattering angle for water (ice I)<br>with $1 \leq \alpha \leq 10$ . . . . .  | 65   |
| 19.    | Intensity versus scattering angle for water (ice I)<br>with $1 \leq \alpha \leq 15$ . . . . .  | 66   |
| 20.    | Intensity versus scattering angle for water (ice I)<br>with $1 \leq \alpha \leq 20$ . . . . .  | 67   |
| 21.    | Intensity versus scattering angle for water (ice I)<br>with $1 \leq \alpha \leq 25$ . . . . .  | 68   |
| 22.    | Intensity versus scattering angle for water (ice II)<br>with $1 \leq \alpha \leq 5$ . . . . .  | 69   |
| 23.    | Intensity versus scattering angle for water (ice II)<br>with $1 \leq \alpha \leq 10$ . . . . . | 70   |
| 24.    | Intensity versus scattering angle for water (ice II)<br>with $1 \leq \alpha \leq 15$ . . . . . | 71   |
| 25.    | Intensity versus scattering angle for water (ice II)<br>with $1 \leq \alpha \leq 20$ . . . . . | 72   |
| 26.    | Intensity versus scattering angle for water (ice II)<br>with $1 \leq \alpha \leq 25$ . . . . . | 73   |

## LIST OF ILLUSTRATIONS

| Figure | Title  | Page |
|--------|--|------|
| 1.     | View from back side of coordinate system showing scattering plane . . . . .              | 48   |
| 2.     | Intensity versus scattering angle for quartz with $1 \leq \alpha \leq 5$ . . . . .       | 49   |
| 3.     | Intensity versus scattering angle for quartz with $1 \leq \alpha \leq 10$ . . . . .      | 50   |
| 4.     | Intensity versus scattering angle for quartz with $1 \leq \alpha \leq 15$ . . . . .      | 51   |
| 5.     | Intensity versus scattering angle for quartz with $1 \leq \alpha \leq 20$ . . . . .      | 52   |
| 6.     | Intensity versus scattering angle for quartz with $1 \leq \alpha \leq 25$ . . . . .      | 53   |
| 7.     | Intensity versus scattering angle for water (ice) with $1 \leq \alpha \leq 5$ . . . . .  | 54   |
| 8.     | Intensity versus scattering angle for water (ice) with $1 \leq \alpha \leq 10$ . . . . . | 55   |
| 9.     | Intensity versus scattering angle for water (ice) with $1 \leq \alpha \leq 15$ . . . . . | 56   |
| 10.    | Intensity versus scattering angle for water (ice) with $1 \leq \alpha \leq 20$ . . . . . | 57   |
| 11.    | Intensity versus scattering angle for water (ice) with $1 \leq \alpha \leq 25$ . . . . . | 58   |
| 12.    | Intensity versus scattering angle for titanite with $1 \leq \alpha \leq 5$ . . . . .     | 59   |
| 13.    | Intensity versus scattering angle for titanite with $1 \leq \alpha \leq 10$ . . . . .    | 60   |

PRECEDING PAGE BLANK NOT FILMED

## TABLE OF CONTENTS

|   | Page |
|---|------|
| INTRODUCTION . . . . .  | 1    |
| THEORY . . . . .  | 1    |
| DISTRIBUTION . . . . .  | 6    |
| TABLES AND GRAPHS FOR POLARIZATION<br>AND INTENSITIES . . . . . | 7    |
| APPENDIX . . . . .  | 133  |
| REFERENCES . . . . .  | 149  |

PRECEDING PAGE BLANK NOT FILMED